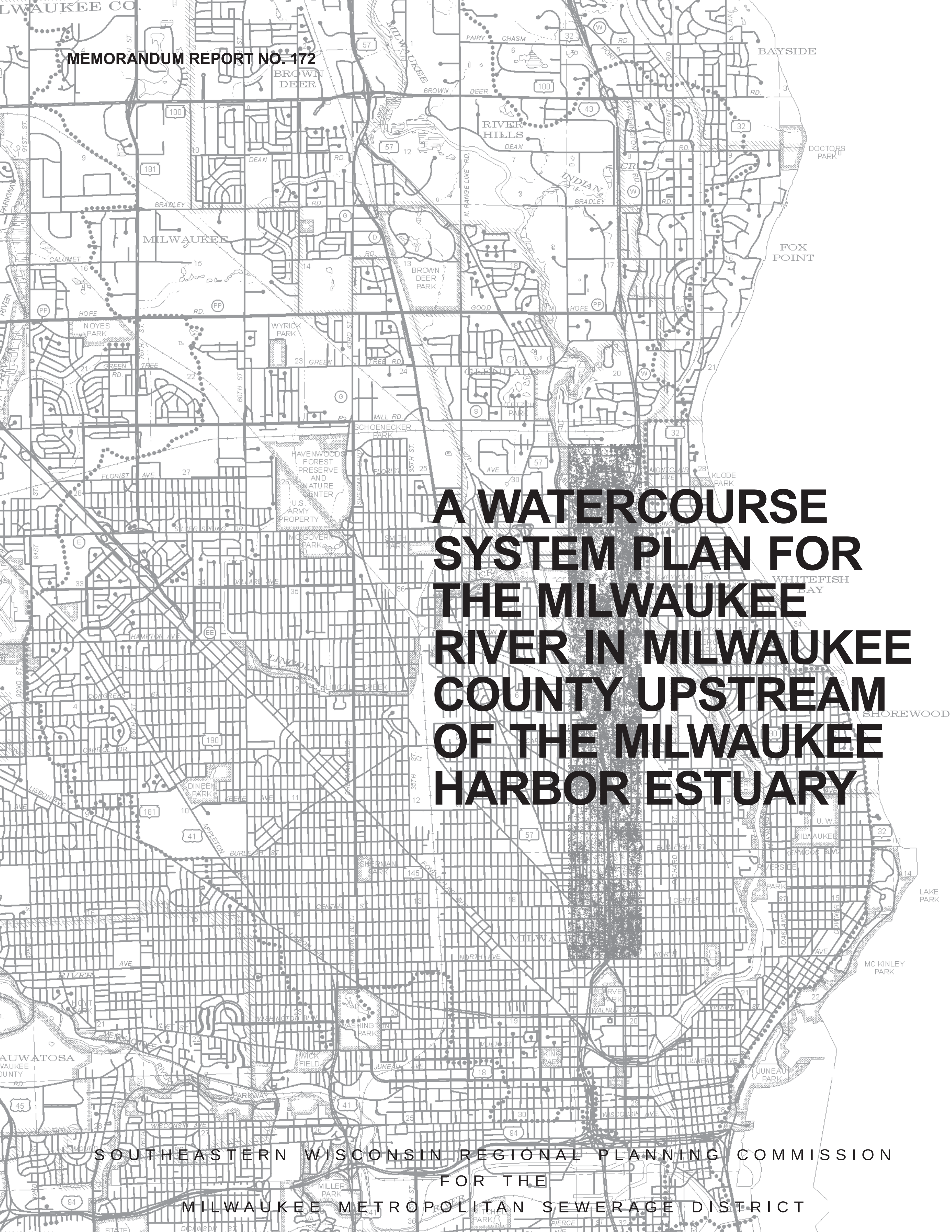


MEMORANDUM REPORT NO. 172

A WATERCOURSE SYSTEM PLAN FOR THE MILWAUKEE RIVER IN MILWAUKEE COUNTY UPSTREAM OF THE MILWAUKEE HARBOR ESTUARY

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION
FOR THE
MILWAUKEE METROPOLITAN SEWERAGE DISTRICT

MEMORANDUM REPORT
NUMBER 172

A WATERCOURSE SYSTEM PLAN FOR THE MILWAUKEE RIVER IN MILWAUKEE COUNTY UPSTREAM OF THE MILWAUKEE HARBOR ESTUARY

Prepared by the

Southeastern Wisconsin Regional Planning Commission
W239 N1812 Rockwood Drive
P.O. Box 1607
Waukesha, Wisconsin 53187-1607
www.sewrpc.org

for the

Milwaukee Metropolitan Sewerage District

December 2010

$10.00

(This Page Left Blank Intentionally)

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

(This Page Left Blank Intentionally)

SEWRPC Memorandum Report No. 172

A WATERCOURSE SYSTEM PLAN FOR THE MILWAUKEE RIVER IN MILWAUKEE COUNTY UPSTREAM OF THE MILWAUKEE HARBOR ESTUARY

INTRODUCTION AND BACKGROUND

In February of 2006, the Milwaukee Metropolitan Sewerage District (MMSD) requested that the Southeastern Wisconsin Regional Planning Commission (SEWRPC) perform hydrologic and hydraulic analyses and evaluate alternative floodland management plans for the mainstem of the Milwaukee River in the 13.2-mile-long reach from the Milwaukee-Ozaukee county line downstream to the upstream limit of the Milwaukee Harbor estuary at the location of the former North Avenue dam. That is the River reach for which the MMSD has assumed jurisdiction for flood control purposes. The analyses are primarily intended to evaluate alternative plans to mitigate flood damages at 393 buildings located within the one-percent-annual-probability (100-year recurrence interval) floodplain of the Milwaukee River in the Cities of Glendale and Milwaukee and the Villages of Brown Deer and River Hills.

The SEWRPC staff has recently completed mapping the Milwaukee River floodplain under planned year 2020 land use and existing channel conditions under a program funded by the Milwaukee Metropolitan Sewerage District, the Milwaukee County Automated Mapping and Land Information System (MCAMLIS) Steering Committee, and the Regional Planning Commission.[1] Under that program, the 10-percent-annual-probability (10-year recurrence interval), two-percent-annual-probability (50-year recurrence interval), one-percent-annual-probability (100-year recurrence interval), and 0.2-percent-annual-probability (500-year recurrence interval) flood profiles were determined and the corresponding flood inundation areas were mapped on large-scale topographic maps prepared by the MCAMLIS Steering Committee at a scale of one inch equals 100 feet and a contour interval of two feet. The maps were prepared in National Geodetic Vertical Datum, 1929 adjustment (NGVD29) and they are referenced to the Wisconsin State Plane Coordinate System, NAD27, South Zone horizontal datum.

The SEWRPC Milwaukee River floodplain maps that form the basis for this analysis have been reviewed by all affected communities in Milwaukee County and the maps and associated flood profiles have been incorporated in the Federal Emergency Management Agency (FEMA) flood insurance study and digital flood insurance rate maps (DFIRMs) for Milwaukee County, which became effective on September 26, 2008. It is anticipated that the DFIRMs will be adopted by all affected communities for local floodplain zoning purposes.

The following tasks were performed under this study as identified in Attachment A to the February 23, 2006, project agreement between the MMSD and SEWRPC:

---

[1]*That floodplain study updates past analyses used for local zoning and Federal Emergency Management Agency (FEMA) flood insurance purposes.*

- Review those components of SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, Volumes 1 and 2, December 1970 and October 1971, respectively, that relate to floodland management along the Milwaukee River mainstem in Milwaukee County;

- Identify structures flooded during floods with annual probabilities of up to one percent and generally categorize the flooded structures as residential, commercial, industrial, or government and institutional;

- Develop three comprehensive alternative plans to mitigate flood problems during events with annual probabilities of one percent or more frequent, including the development of total capital costs, annual operation and maintenance costs, and average annual cost for each alternative plan;

- Consider water quality improvement, riparian and aquatic habitat, regulatory issues, safety considerations, and operation and maintenance requirements in developing and evaluating the alternative plans; and

- Identify a work plan and schedule to implement the recommended plan.

DESCRIPTION OF STUDY AREA

As shown on Map 1, the approximately 700-square-mile Milwaukee River watershed includes portions of the Dodge, Fond du Lac, Milwaukee, Ozaukee, Sheboygan, and Washington Counties; five cities, 21 villages, and 30 towns. As shown on Map 2, the main tributaries to the Milwaukee River are the East, North, and West Branches of the Milwaukee River and Cedar Creek.

This study considered the effects of runoff from the entire watershed, but the hydraulic analysis focused on the 13.2-mile-long reach of the Milwaukee River mainstem from the Milwaukee-Ozaukee county line, to the upstream limit of the Milwaukee Harbor estuary at the site of the former North Avenue dam.

HYDROLOGIC AND HYDRAULIC ANALYSIS

Hydrologic Analysis
The hydrologic analyses conducted by the SEWRPC staff are described in Appendix A. Those flows have been incorporated in the September 26, 2008, FEMA flood insurance study for Milwaukee County.

Hydraulic Analyses
Ten-percent-probability through 0.2-percent-probability flood profiles for the Milwaukee River were computed using the U.S. Army Corps of Engineers HEC-RAS River Analysis Systems model developed by the SEWRPC staff.

Determination of Flood Flows and Profiles
Flood flows and profiles along the Milwaukee County portion of the Milwaukee River upstream of the Milwaukee Harbor estuary were determined for planned year 2020 land use and existing channel conditions. Ten-, two-, one-, and 0.2-percent-annual-probability (ten-, 50-, 100, and 500-year recurrence intervals, respectively) flood flows and stages are set forth in Appendix B.

BASIC CONCEPTS AND RELATED DEFINITIONS

Flooding is defined as inundation of the floodplain of a stream—that is, of the relatively wide, low-lying, flat to gently sloping areas contiguous to and usually lying on both sides of the stream channel, as a direct result of stream water moving out of and away from the major stream channels. Flooding is a natural and certain process in hydrologic-hydraulic systems—one that is unpredictable only in the sense that the exact time of occurrence of a flood of a given magnitude cannot be predetermined, although the probability of occurrence of such a flood is amenable to engineering analyses. How much of a natural floodland will be flooded during a given event depends on the severity of the flood and, more particularly, on the peak elevation of the floodwaters. Thus, an infinite number of outer limits of natural floodlands may be delineated, each related to a specified probability of occurrence as determined by engineering analyses. Based upon such analyses, floodlands may be delineated on large-scale topographic maps as continuous linear areas lying along the streams and watercourses. Flooding is not necessarily synonymous with the presence of flood problems. Flood problems—and the demand for flood damage reduction measures—are created only when flood damage-prone land uses are allowed to intrude upon the natural floodlands of the watershed in such a fashion and to such an extent that the certain, although random, inundation of the floodlands results in disruption, monetary damages, and risks to human health and life.

Stormwater inundation is defined herein as the localized ponding of stormwater runoff which occurs when such runoff moving toward streams and other low-lying areas exceeds the conveyance and storage capacities of the stormwater management system and temporarily accumulates on the land surface. Stormwater runoff is conveyed and/or stored in networks consisting of overland or sheet flow, small intermittent channels, storm sewers, other drainageways, and detention storage facilities.

Stormwater inundation and riverine area flooding, as defined herein, differ in several significant ways. While stormwater inundation involves water moving downslope toward major rivers, flooding is caused by water moving in the opposite way, that is, out and away from major stream channels. In contrast to areas experiencing flooding, areas experiencing stormwater inundation tend to be a discontinuous, series of relatively small and scattered pockets not necessarily located in the lowest areas or near major streams or even near small intermittent channels or other well-defined drainageways. The definition of urban areas subject to stormwater inundation requires detailed analysis of local topography and local street and associated building grades and of local stormwater drainage and sanitary sewerage systems, whereas the definition of floodprone areas requires a broader, watershedwide analysis of the riverine areas of the major streams.

Stormwater problems are not necessarily synonymous with stormwater inundation. Stormwater problems, and the demand for works and measures to control stormwater runoff as it moves toward the natural and man-made drainageways, are created only when urban development occurs without proper regard for stormwater runoff conveyance and storage needs. Such local problems in urban design are to be differentiated from the areawide problems of flooding. Resolution of local stormwater drainage problems requires the preparation of detailed stormwater management plans which are beyond the scope of this systems level flood management plan. Rather, this plan addresses the stormwater management needs of the area to the extent that stormwater management and flood control are interrelated. This specifically relates to the need to provide interior stormwater drainage facilities under the alternative plan that calls for levees to be provided along certain floodprone reaches

HISTORICAL FLOODING INFORMATION

Information on significant historical floods along the Milwaukee River in the 94-year period from 1915 through 2008 during which the U. S. Geological Survey (USGS) has operated continuous recording streamflow gage No. 04087000 near Estabrook Park is set forth in Table 1. Major floods from 1918 to 1970 are described in the SEWRPC Milwaukee River watershed study.[2] The study report mentions “frequent and extensive historic flood damage” that occurred in the “Sunny Point Lane Peninsula area in the City of Glendale.” That general area was identified as being in the one-percent-annual probability floodplain delineated under the study documented herein.

Map 3, which is taken from SEWRPC PR No. 13, indicates the extent of flooding during the 1924 flood along the Milwaukee River in a portion of the City of Glendale. That flood had an estimated annual probability of occurrence of 0.8 percent, or a recurrence interval of about 125 years. The documented area flooded is quite similar to the one-percent-annual-probability (100-year recurrence interval) floodplain as delineated under this

---

[2]*SEWRPC Planning Report No. 13*, A Comprehensive Plan for the Milwaukee River Watershed, *Volume 1*, Inventory Findings and Forecasts, *December 1970.*

study (see Map 4). A comparison of Map 3 (which uses a 1936 base map) and Map 4 (which uses a 2005 digital orthophotograph base map) indicates that extensive development occurred within the floodplain after 1936.

The largest flood recorded in the 94-year period of record of the USGS gage was 16,500 cfs on June 21, 1997. As indicated in Table 1, it is estimated that that flood had an annual probability of occurrence of 0.5 percent, or a recurrence interval of 200 years. Based on flood damage reports compiled by local officials and submitted to the Wisconsin Division of Emergency Management (WDEM) and FEMA, the 1997 flood caused minor damage to 128 homes. The report to the WDEM and FEMA is included in Appendix C.

The June 2008 flood, which had an estimated probability of occurrence of 5 percent (20-year recurrence interval), did not result in significant flooding along the study reach of the Milwaukee River in Milwaukee County, based on news reports and field observations by the SEWRPC staff.

ESTIMATION OF POTENTIAL FLOOD DAMAGES

Determination of the Cause of Flood Damage

Flood damages in urban areas, such as the Milwaukee River floodplain in Milwaukee County, are caused primarily by the inundation of buildings and, to a lesser extent, by the inundation of roadways and utilities. Residential, commercial, and industrial buildings are particularly vulnerable to flood damage partly because of the many ways in which floodwaters can enter such structures.

As illustrated in Figure 1, an unprotected floodland structure is vulnerable to the entry of floodwaters in a number of ways. Rising floodwaters may surcharge the sanitary or storm sewers in an urban area, thereby reversing the flow in these sewers and forcing water into the structures through basement floor drains, plumbing fixtures, and other openings connected to the sewer system. As a result of saturated soil conditions around structure foundations, water may enter through cracks or structural openings in basement walls or floors. If overland flooding occurs—that is, flood stages rise above the elevation of the ground near a particular residential, commercial, industrial, or institutional structure—floodwater may enter the basement of the structure through basement doors, windows, and other structural openings. If flood stages rise high enough, floodwaters similarly may gain access to the first or main floor of a structure. In addition to the inundation damage to the structure and its contents, external hydrostatic pressures may cause the uplift and buckling of basement floors and the collapse of basement walls. Finally, floodwaters may exert hydrostatic or dynamic forces of sufficient magnitude to lift or otherwise move a structure from its foundation.

Flood damage can occur to the basements of structures located outside of the geographic limits of overland flooding when floodwaters gain access via the hydraulic connections between the inundated area—the area of primary flooding—and basements that are provided sanitary, storm, or combined sewer systems. Such flooding of basements outside of, but adjacent to, the area of primary flooding is herein defined as secondary flooding. The extent of secondary flooding that is directly related to the overflow of streams is difficult to define, because it cannot be readily distinguished from other types of basement flooding such as that caused by sanitary sewer backups related to factors such as infiltration and inflow to sanitary sewers and to operation of the MMSD Inline Storage System (ISS), or deep tunnel. Mitigation of secondary flooding of basements, requires a set of coordinated measures involving stormwater and floodland management, other controls on infiltration and inflow to sanitary sewers, sanitary sewerage system conveyance improvements, and continued adjustment of MMSD procedures for real-time operation of the ISS. Such measures are being undertaken at the local level and by MMSD.[3] The flood mitigation measures considered under this watercourse system plan are a single, but significant, component of the multiple actions needed to address the various factors contributing to secondary flooding. As such, they alone would not be sufficient to completely alleviate secondary flooding. Therefore, damages attributed to secondary flooding were not included in the flood damage estimates determined under this study. Primary and secondary flooding zones are illustrated in Figure 2.

---

[3]*See* MMSD 2020 Facilities Plan, *June 2007.*

Monetary Flood Losses and Risks

Computation of Monetary Flood Damages

Monetary flood damages for flood events of specified probabilities of occurrence, as well as average annual damages under probable year 2020 land use conditions throughout the Milwaukee River watershed, were determined for selected stream reaches to permit economic evaluation of alternative flood control measures. The information required to compute monetary flood damages to structures and contents includes data: 1) on the types of structures affected; 2) on the elevation of the ground at the structure and on the elevation of the first floor; 3) on the existence or absence of a basement; 4) on the fair market value of potentially flooded structures; and 5) on the value of the contents of affected structures. Indirect flood damages, and the method of determination of those damages are described later.

Flood damage can be defined as the physical deterioration or destruction caused by floodwaters. The term flood loss refers to the net effect of flood damage on the regional economy and well being, with the components of the loss being expressed in monetary units. Flood risk is the probable damage, expressed either on a per flood event basis or on an average annual basis, that will be incurred as a result of future flooding with the tangible portion of the risk expressed in monetary terms. All losses resulting from historical flooding or the risk attendant to future flooding can be classified into one of three types of damage categories—direct, indirect, and intangible.

Flood Losses and Risks Categorized by Type

To promote compatibility with the policies and practices of Federal agencies, such as the U.S. Army Corps of Engineers, the following three categories of flood losses and risks were defined for the purpose of the study:

- Direct flood losses or risks are defined as monetary expenditures required, or which would be required, to restore flood-damaged property to its pre-flood condition. In an urban setting, this includes the cost of cleaning, repairing, and replacing residential, commercial, industrial, and institutional buildings and contents. Direct losses and risks also encompass the cost of cleaning, repairing, and replacing roads and bridges, stormwater systems, sanitary sewer systems, and other utilities; and the cost of restoring damaged park and recreational lands.

- Indirect flood losses and risks are defined as the net monetary cost of evacuation, relocation, lost wages, lost production, and lost sales; the increased cost of highway and railway transportation because of flood-caused detours; the costs of flood-fighting and emergency services provided by governmental units; the cost of post-flood flood-proofing of individual structures. The costs of post-flood engineering and planning studies also are categorized as indirect losses and risks. Although often difficult to determine with accuracy, indirect losses and risks nevertheless constitute a real monetary burden on the economy of the Region.

- Intangible flood losses and risks were defined as flood effects which cannot be readily measured in monetary terms. Such losses and risks include health hazards, property value depreciation as a result of flooding, and the general disruption of normal community activities. Intangible losses and risks also include the psychological stress experienced by owners or occupants of riverine area structures.

Flood Losses and Risks Categorized by Ownership

As already noted, flood losses and risks may also be classified on the basis of ownership into public-sector and private-sector losses and risks. Each of the three categories of flood loss—direct, indirect, and intangible—may, therefore, be further subdivided into public-sector and private-sector losses as shown in Table 2. Within the direct loss category, for example, the cost of cleaning, repairing, and replacing residential buildings and their contents is a private-sector flood loss, whereas the cost of repairing or replacing damaged bridges and culverts is a public-sector loss.

Role of Monetary Flood Risks

A previous section of this report identified the major historical flood events known to have occurred within the watershed and the relative magnitude of simulated or recorded peak flood discharges. That section also described the severity of major flood events and the general areas that were affected. While such a qualitative description of flooding is an effective means of communicating the characteristics of flooding, it is not adequate for sound economic analyses of alternative solutions to flood problems. Such analyses require that flood damages for the various stream reaches be quantified in monetary terms on a uniform basis.

The quantitative, uniform means of expressing flood damages selected for use in this study was the average annual flood damage risk expressed in 2006-2008 dollars. Expected annual flood risk was computed for floodprone reaches to provide a monetary value that could be used, wholly or in part, as an annual quantity for comparison to annual costs of technically feasible alternative flood control measures.

Methodology Used to Determine Expected Annual Flood Risks

The expected annual flood damage risk for a stream reach is defined as the sum of the direct and indirect monetary flood losses resulting from floods of all probabilities, each weighted by its probability of occurrence or exceedance in any year. If a damage-probability curve is constructed, such as the graph of dollar damage versus flood probability illustrated in Figure 3, the expected annual damage is represented by the area beneath the curve. The damage-probability curve for each floodprone reach is developed by combining the reach stage-probability relationship with the reach stage-damage curve as illustrated in Figure 3. The determination of expected annual flood risk for a particular floodprone reach, therefore, depends upon construction of the stage-probability and stage-damage relationships for the reach.

The two required relationships for a particular reach would be ideally developed from a long series of stage observations which could be analyzed statistically to yield the stage-probability curve and from a similar long series of recorded direct and indirect damages actually experienced by riverine area occupants for a full range of flood stages. Inasmuch as neither the long-term river stage information nor the damage information were available for the subject reach of the Milwaukee River, it was necessary to develop the stage-probability and stage-damage relationships by analytical means and then to combine them to form the damage-probability relationship.

Synthesis of Reach Stage-Probability Relationships

The stage-probability relationship for a particular reach is determined by the hydraulic characteristics of the reach, such as the shape of the floodland cross-sections, the value of the Manning roughness coefficients, and the presence of bridges, culverts, and other structures—all of which are to some extent determined by human activities—plus the magnitude of flood flows expected in the reach. These flood flows are, in turn, a function of upstream hydraulics and hydrology which are also, because of human activities, continuously undergoing change or have the potential to do so. It follows that each reach does not have a unique stage-probability curve but instead has many possible stage-probability curves, each of which is associated with a given combination of hydrologic and hydraulic conditions in and upstream of the reach in question.

Synthesis of Reach Stage-Damage Relationships

The stage-damage curve for a reach is determined by the nature and extent of floodprone structures and other property, including agricultural lands, contained within the reach. It follows that there is a separate stage-damage curve for each combination of riverine area land uses. Development of the stage-damage relationship for a particular combination of riverine area land uses in a reach begins with computation of the flood losses that may be expected for an arbitrarily selected flood stage slightly above the elevation of the river channel. These flood losses consist of estimates of the direct and indirect monetary flood losses. Upon completion of the summation of flood losses at the initial flood stage, a higher stage is considered. This process is repeated so as to consider the full spectrum of flood stages from just above the river bank up to the one-percent-annual-probability flow stage. Figure 3 presents an example of a hypothetical, synthesized stage-damage curve.

Synthesis of reach stage-damage relationships requires the use of depth-damage relationships for the various type structures, facilities, croplands, and activities likely to be present in or to occur in floodlands. A depth-damage relationship for a particular type of structure is a graph of depth of inundation in feet relative to the first floor versus dollar damage to the structure expressed as a percent of the total dollar value of the structure. A similar, separate relationship can be developed for the contents of a structure. The depth-damage relationships applied for this study are consistent with current FEMA depth-damage information.

The depth-damage curves do not take into account the duration of flooding, assuming, in effect, that if inundation occurs, damages will be incurred. This is a realistic assumption for the urban structure damages where inundation for even very short periods of time will damage such costly components as electrical motors, controls, and equipment; furnishings; and interior decorating.

Determination of Indirect Damages

The above depth-damage relationships reflect the direct damage to each of the various types of structures as the function of the depth of inundation. Indirect damages, which can be a significant portion of the total monetary losses incurred during a flood event, were computed as a percentage of the direct damages to the various types of structures. The direct damages to commercial and industrial structures were increased by 40 percent to account for indirect damages, whereas the direct damages to residential and all other noncommercial and nonindustrial structures were increased by 15 percent to reflect indirect damages.

Expected Annual Flood Risks

The above methodology was used to compute expected annual flood risks for selected reaches along the Milwaukee River study reach under existing floodland development-land use conditions. The inventory of buildings in the 10-, two-, one-, and 0.2-percent probability floodplains in set forth in Table 3. The resulting total and expected annual flood risks by municipality are presented in Tables 4 and 5. The average annual flood damage was estimated to be $674,200. Total damages expected to be caused by the 10-, two-, one-, and 0.2-percent-probability flood events were determined to be $1.51 million, $7.62 million, $12.80 million, and $28.91 million, respectively.

SUMMARY OF FLOODLAND MANAGEMENT RECOMMENDATIONS OF THE SEWRPC MILWAUKEE RIVER WATERSHED STUDY

The 1971 SEWRPC Milwaukee River watershed study (documented in PR No. 13) includes the following nonstructural floodland management recommendations that were intended to be implemented throughout the watershed:[4]

- All homes and major structures in the flood fringe that are not subject to first-floor flooding should be floodproofed.
- All homes and major structures in the floodway should eventually be removed under a voluntary program to be established by local public agencies.
- Local zoning ordinances should be revised as necessary to prohibit urban development in undeveloped and unplatted floodlands of the watershed.

Those recommendations were adopted by the Milwaukee River Watershed Committee after careful consider of a wide range of structural and nonstructural alternative plans that included:

- Structure floodproofing along with structure acquisition and removal,

---

[4]*The floodfringe and floodway as set forth on Map 4 are both related to the one-percent-annual- probability (100-year recurrence interval) flood. The floodway is defined as that portion of the floodplain which conveys flood flows, and the floodfringe is defined as that portion of the floodplain that is outside the floodway, and in which floodwaters are temporarily stored, rather than conveyed.*

- Construction of a levee/floodwall system to protect structures in the City of Glendale as well as in the City of Mequon and the Villages of Saukville and Thiensville,

- Floodwater diversion, and

- Flood control reservoirs.

The study presented herein can be viewed as a targeted refinement of the Milwaukee River watershed study which specifically addresses the flood hazard in Milwaukee County outside the estuary and which recognizes the many changes in terms of land development, floodplain regulations, and environmental considerations that have taken place in the years since the Milwaukee River watershed study was adopted.

ANALYSIS OF ALTERNATIVE FLOODLAND MANAGEMENT PLANS FOR THE MILWAUKEE RIVER

Formulation of Alternative Flood Control Measures

Possible alternative flood control measures include acquisition and removal of floodprone structures, structure floodproofing, structure elevation, the provision of detention storage of runoff, channel modification, construction of levees or floodwalls along with provision of interior drainage facilities, floodwater diversion, or some combination of these measures. In the formulation of alternative flood control measures for a particular reach, the nature and causes of the existing and possible future flood problems in that reach as determined from historical flood information and from simulation of the flood potential under planned conditions in the absence of control measures were carefully considered.

The alternative plans described below incorporate, alone, or in combination:

- Acquisition and removal of floodprone structures,

- Structure floodproofing,

- Structure elevation, and

- Construction of levees or floodwalls along with provision of interior drainage facilities.

During the pre-analysis coordination meeting with MMSD staff, it was decided that channel modification would be eliminated as a potential management option because it is not consistent with the study criteria related to water quality improvement and preservation of riparian and aquatic habitat. In addition, such an option was considered and rejected under the 1971 SEWRPC Milwaukee River watershed study.

Floodwater diversion to Lake Michigan was eliminated because 1) it is a disruptive option when applied in an area of significant existing development, 2) it is likely that it would not be cost-effective, and 3) it could create negative environmental conditions in the River at, and downstream of, the diversion and in Lake Michigan in the vicinity of the diversion outfall. A diversion alternative was considered and rejected under the 1971 SEWRPC Milwaukee River watershed study on the basis that it would not be cost-effective.

The Advisory Committee for the 1971 Milwaukee River watershed study rejected an alternative that called for a large (85,000 acre-foot flood storage volume) online, multi-purpose recreation and flood control reservoir at Waubeka because 1) the flood control benefits were a very small portion of the total benefits (7 percent flood control versus 93 percent recreational benefits), 2) there was neither the institutional structure, nor the public support for a primarily recreational reservoir, 3) by reducing peak flood flows, the reservoir would alter the natural characteristics of the environmental corridors downstream from the dam and perhaps create development pressure in those areas, 4) construction of a dam and reservoir would be improbable given the growing opposition of conservation interests to those types of projects, and 5) the Federal government would be unable to significantly fund the project.

The provision of detention storage of runoff at off-line locations is embodied to some degree in the MMSD Chapter 13 “Surface Water and Storm Water” rule which requires limitations on peak rates of runoff from new development within the MMSD jurisdictional area. The intent of that rule is to avoid increasing peak flood flows as development proceeds. However, the provision of detention storage facilities within the watershed to provide significant flood relief through substantial reductions in peak flood flows along the Milwaukee River mainstem is not likely to be effective because:

- The large size of the watershed, and the location of the flood damage center in question near the downstream end of the watershed, limits the ability of scattered detention storage facilities to significantly affect peak flows on the mainstem;

- Implementing such facilities could include significant modification of the land surface of many remaining areas of open space or low-density development, including existing park land, which may be unacceptable to Milwaukee County and to communities where facilities could be located, but in which there is little or no flood damage potential along the Milwaukee River and, thus, little or no benefit from damage reduction; and

- Implementing such facilities could also involve substantial disruption of existing neighborhoods through acquisition and demolition of buildings outside the floodplain for the purpose of constructing detention storage facilities.

Study Criteria

The SEWRPC staff developed and evaluated measures designed to mitigate structural flood damages to 393 inhabited residential, commercial, or recreational structures resulting from overflow of the Milwaukee River in the reach from the Ozaukee-Milwaukee county line to the upstream limit of the Milwaukee Harbor estuary at the site of the former North Avenue dam. Consistent with MMSD watercourse system planning criteria and standard flood control practice, the alternative plans are designed to alleviate flood damages during floods with annual probabilities of occurrence of one percent or greater. The alternative plans were generally designed to avoid increases in the one-percent-probability flood profile relative to planned land use and existing channel conditions, unless noted otherwise.

Description of Stream Reaches with Potential Flood Damages

Flooding of Buildings

Map 4 shows the extent of the one-percent-probability floodplain along the study reach of the Milwaukee River. Within that floodplain, there are 384 inhabitable buildings within the City of Glendale, three within the City of Milwaukee, three within the Village of Brown Deer, and three within the Village of River Hills. The flood hazard within the City of Glendale is concentrated in the approximately 2.25-mile-long reach extending from Daphne Road extended downstream (south) to Silver Spring Drive. The flood hazard within the City of Milwaukee occurs west of the River along or near N. Milwaukee River Parkway south of W. Silver Spring Drive. The flood hazard within the Village of Brown Deer occurs west of the River and south of W. River Lane. The flood hazard within the Village of River Hills occurs east of the River along N. River Road, just north of W. Good Hope Road, and at the Milwaukee Country Club.

Table 3 indicates the estimated number and types of buildings in each affected municipality that would be flooded during the 10-, two-, one-, and 0.2-percent-annual-probability floods, and Table B-1 sets forth 10-percent through 0.2-percent-annual-probability flood stage elevations in the subject reach of the River for planned year 2020 land use and existing channel conditions.

Flooding of Roadways
None of the bridge decks at public road crossings along the River would be expected to flood during events with annual probabilities of occurrence of 0.2 percent or more, assuming the bridge openings remain unobstructed.

Streets in the overbanks within the main flood damage reach in the City of Glendale between W. Daphne Road on the north and W. Silver Spring Drive on the south would be flooded. The most notable instance of potential flooding in that reach is an approximately 2,100-foot-long stretch of Bender Road east of the River which could be flooded to a maximum depth of about 4.8 feet during a one-percent-probability flood (Map 4, sheet 2).

Additional potential street flooding locations and estimated maximum flooding depths during a one-percent-probability flood are:

- N. Milwaukee River Parkway at the following locations from north to south:
    - City of Glendale, west of River, several hundred feet south of W. Bender Road, isolated flooding, approximately 1.5-foot maximum depth (Map 4, sheet 2),
    - City of Glendale, west of River, several hundred feet west of N. Sunny Point Road and southeast of the Glendale City Hall and Fire Department, approximately 1.3-foot maximum depth (Map 4, sheet 2),
    - City of Milwaukee, west of River, south of W. Silver Spring Drive, 2,000-foot-long stretch of N. Milwaukee River Parkway and short portion of W. Lawn Avenue, approximately 4.4-foot maximum depth in N. Milwaukee River Parkway (Map 4, sheet 3), and
    - City of Milwaukee, west of west River channel in Lincoln Park and north of W. Hampton Avenue, approximately 0.1-foot maximum depth (Map 4, sheet 3).
- Village of Shorewood, east of River, approximately one-foot maximum depth at west end of Morris Boulevard cul-de-sac (Map 4, sheet 4).

Alternative Plan No. 1 – Acquisition and Demolition of Buildings in the One-Percent-Annual-Probability Floodplain
Under this alternative plan, each of the 393 inhabitable buildings within the one-percent-probability floodplain would be purchased, demolished, and removed from the floodplain by the MMSD. The open space that would be created would remain in public ownership and would be prohibited from future development with inhabited structures. The approximate extents of the areas in which buildings would be purchased under this alternative are shown on Map 5.

The costs of acquisition of land and buildings were estimated based on year 2006 or 2007[5] fair market values for each municipality. Costs of demolition, relocation assistance, moving expenses, title insurance, closing costs, appraisal, surveys, property taxes, and miscellaneous fees were estimated to average $45,000 per residential structure and $80,000 per commercial or recreational[6] structure. Those cost estimates include the $25,000 residential relocation reimbursement consistent with Chapter Comm 202, "Relocation Assistance," of the *Administrative Code*. The additional costs included in the unit amount are consistent with actual costs for recent floodplain building acquisition and demolition projects undertaken by MMSD and by Kenosha County in cooperation with SEWRPC.

---

[5]*Depending on availability of information at the time the analysis was performed.*

[6]*Milwaukee Country Club.*

As set forth in Table 6, the estimated total cost to implement this alternative plan is $107.6 million. Based on a project life of 50 years and an interest rate of 6 percent, the average annual cost of the alternative is estimated to be $6.86 million. The annual benefits of implementing this alternative would be equal to the damages prevented during a one-percent-probability flood plus the estimated incremental benefit of acquiring and demolishing 393 houses that would no longer be subjected to flood damages under any flood conditions, including floods with probabilities of occurrence less than 1 percent. The total average annual benefit is estimated to be about $581,200. Thus, the benefit-cost ratio is 0.08.

Alternative Plan No. 2 – Floodproofing, Elevation, or Acquisition and Demolition of Buildings in the One-Percent-Annual-Probability Floodplain

Under this alternative plan, 145 buildings would be floodproofed, 177 buildings would be elevated, and 71 buildings would be purchased and demolished and removed from the floodplain. The open space that would be created in areas where buildings were removed would remain in public ownership and would be prohibited from future development with inhabited structures. The approximate extents of the areas in which buildings would be floodproofed, elevated, or purchased under this alternative are shown on Map 6.

It was assumed that floodproofing of residential structures would be feasible if the one-percent-probability flood stage was below the estimated first floor elevation. Structure elevation was considered feasible for residential structures with basements if the estimated cost of elevating the structure was less than the estimated cost of removing the structure. It was also assumed that structures would be elevated two feet above the one-percent-probability flood stage, and that the maximum structure elevation height would be four feet above grade. If a structure would have to be elevated more than four feet to achieve the desired two feet of freeboard above the design flood stage, it was assumed that the structure would be purchased and demolished. Floodproofing was assumed to be feasible for all nonresidential structures provided that the flood stage would not be more than seven feet above the first floor elevation.

The costs of acquisition of land and buildings were estimated in the same manner as for Alternative No. 1. The average cost of floodproofing a single-family house was estimated as $17,000, and the cost of floodproofing a commercial building was estimated as 7 percent of the fair market value of the structure plus 0.05 times the height of floodproofing above the first floor times the fair market value of the structure.

As set forth in Table 7, the estimated costs are 1) $2.5 million to floodproof 145 buildings, 2) $15.9 million to elevate 177 buildings, and 3) $19.8 million to acquire and demolish 71 buildings, yielding a total capital cost of $38.2 million. Based on a project life of 50 years and an interest rate of 6 percent, the average annual cost of the alternative is estimated to be $2.44 million. The annual benefits of implementing this alternative would be approximately equal to the equivalent annual damages prevented during a one-percent-probability flood plus the estimated incremental benefit of acquiring and demolishing 71 houses that would no longer be subjected to flood damages under any flood conditions, including floods with probabilities of occurrence less than 1 percent. The total average annual benefit is estimated to be about $459,500. Thus, the benefit-cost ratio is 0.19.

Alternative Plan No. 3 – Levee for Protection from the One-Percent-Annual-Probability Flood with Floodproofing, Elevation, or Acquisition and Demolition of Selected Buildings

Under this alternative plan, two levees would be constructed as shown on Map 7. The levee along the left bank (looking downstream) would be about 7,500 feet long, and the levee along the right bank would be about 6,500 feet long. To avoid creating hydraulic constrictions through narrowing of the floodway, the levees were assumed to be aligned so that the riverward levee toe would be located at the delineated floodway boundary. As a result, buildings that are currently within the floodway would not be protected and were designated to be purchased, demolished, and removed. In addition, buildings located along, or very close to, the levee alignment were also designated to be purchased and demolished.

The levees proposed under this alternative plan would protect 287 of the 391 buildings in the one-percent-probability floodplain. An additional seven buildings would be floodproofed (three in the City of Milwaukee, three in the Village of Brown Deer, and one in the Village of River Hills),[7] one building in River Hills would be acquired and demolished, and one building in River Hills would be elevated. Also, 110 inhabitable buildings within the one-percent-probability floodplain and riverward of the levees or along the levee alignment would be purchased, demolished, and removed from the floodplain by the MMSD. [8] The open space that would be created would remain in public ownership and would be prohibited from future development with inhabited structures.

Because the levees would block the overland flow path for stormwater runoff to reach the Milwaukee River, this alternative provides for interior stormwater drainage facilities consisting of seven pump stations at the preliminary locations shown on Map 7. The pump stations were sized to pump the peak flow during the critical duration one-percent-probability (100-year recurrence interval) storm. Associated storm sewer system improvements would also be required to ensure that runoff during storms with annual probabilities up to, and including, 1 percent can be conveyed to the pump stations.

The costs of acquisition of land and buildings were estimated in the same manner as for Alternative No. 1, and floodproofing costs were estimated as described for Alternative No. 2.

Construction of levees would block the connection between portions of the current floodplain and the River, resulting in an estimated loss of floodwater storage of about 460 acre-feet, or approximately 6 percent of the existing total floodwater storage in the one-percent-probability floodplain between the former North Avenue dam and the Milwaukee-Ozaukee county line. The loss of that storage could increase flood flows and raise flood profiles along the River. Any increase in the one-percent probability flood stage resulting from that loss of storage would either have to be mitigated through the provision of compensatory storage, or legal arrangements for any increase in the flood stage of 0.01 foot or greater would have to be made with all affected property owners and affected municipalities would have to be notified. Within Milwaukee County, the provision of adequate compensatory storage would be difficult without significantly disturbing existing County park land. It might be possible to provide compensating floodwater storage along the River upstream of Milwaukee County if appropriate open lands could be purchased and graded to develop the necessary storage volume.

As set forth in Table 8, the estimated costs are 1) $5 million to construct the levees; 2) $21.3 million to acquire and demolish 71 buildings along the proposed levee alignment; 3) $22.5 million to provide stormwater pumping stations and associated storm sewer system upgrades for interior drainage; 4) $1.0 million to acquire land along the levee alignment; 5) $10.9 million to acquire and demolish 39 buildings located riverward of the levee; 6) $120,000 to floodproof three houses in the City of Milwaukee, three houses in the Village of Brown Deer, and one recreational building in the Village of River Hills; 7) $90,000 to elevate one building in the Village of River Hills; and 8) $300,000 to acquire and demolish one building located in the Village of River Hills, yielding a total capital cost of $61.21 million. Annual operation and maintenance costs for the levees and the pump stations are estimated to be $40,000 and $140,000, respectively. Based on a project life of 50 years and an interest rate of 6 percent, the average annual cost of the alternative is estimated to be $4.07 million. The annual benefits of $603,500 for implementing this alternative would be approximately equal to the equivalent annual damages prevented during a one-percent-probability flood in the City of Milwaukee and the Village of Brown Deer, plus 1) the approximate damages prevented up to a 0.2-percent-probability flood in the City of Glendale, where the levees would be designed to meet State and Federal standards requiring freeboard adequate to at least contain that flood

---

[7]*The same floodproofing, elevation, and acquisition and demolition criteria as for Alternative No. 2 were applied for this Alternative.*

[8]*Because of the need to terminate the levees at high ground and to meet State and Federal freeboard requirements, approximately 13 of the buildings to be acquired and demolished for levee construction are located outside the one-percent-probability floodplain.*

and 2) the estimated incremental benefit of acquiring and demolishing one house in the Village of River Hills that would no longer be subjected to flood damages. The benefit-cost ratio for this alternative 0.15.

EVALUATION OF THE ALTERNATIVE PLANS

Cost

A comparison of the costs of each of the alternative plans is set forth in Table 9. Alternative No. 1 – Acquisition and Demolition of Buildings in the One-Percent-Annual-Probability Floodplain (hereinafter referred to as the "Acquisition" alternative) has the highest capital and average annual costs of $107.6 million and $6.86 million, respectively, followed by Alternative No. 3 – Levee for Protection from the One-Percent-Annual-Probability Flood with Floodproofing, Elevation, or Acquisition and Demolition of Selected Buildings (hereinafter referred to as the "Levee" alternative), which has capital and average annual costs of $61.21 million and $4.07 million, respectively, and by Alternative No. 2 – Floodproofing, Elevation, or Acquisition and Demolition of Buildings in the One-Percent-Annual-Probability Floodplain (hereinafter referred to as the "Floodproofing" alternative), which has capital and average annual costs of $38.2 million and $2.44 million, respectively. The benefits from full implementation of the plans are greatest for Alternative No. 3 ($603,500), followed by Alternative No. 1 ($581,200), and then No. 2 ($459,500), but Alternative No. 2 has the highest benefit-cost ratio (0.19), followed by Alternative No. 3 (0.15), and Alternative No. 1 (0.08). The No Action alternative would have an average annual cost of $674,200, which is equal to the anticipated average annual flood damages. That alternative would only be considered further if it were decided that the municipalities were willing to accept periodically recurring flood damages. Assuming the No Action alternative is unacceptable, based on cost and benefit-cost ratio, the Floodproofing Alternative (No. 2) is preferable.

Implementability

While this evaluation category is more subjective than cost, it is possible to evaluate and compare the relative implementability of the three alternative plans. Because the Levee Alternative provides a comprehensive solution that would have the least reliance on actions directed toward individual properties (i.e., acquisition, floodproofing or elevation), it is judged to be the most readily implementable alternative. However, as noted previously, any increase of 0.01 foot or greater in the one-percent probability flood stage resulting from the loss of floodwater storage volume under the Levee Alternative would either have to be mitigated through the provision of compensatory storage, or legal arrangements would have to be made with all affected property owners and affected municipalities would have to be notified. The provision of adequate compensatory storage within Milwaukee County would be difficult without significantly disturbing existing park land. It might be possible to provide compensating floodwater storage along the River upstream of Milwaukee County if appropriate open lands could be purchased and graded to develop the necessary storage volume. Either the need to obtain legal arrangements with affected property owners, or to provide compensatory floodwater storage would make implementation of the Levee Alternative difficult.

Of the two remaining alternative plans, the Acquisition Alternative would probably be more readily implemented than the Floodproofing Alternative in that, while the Acquisition Alternative would involve dealing with 393 individual property owners, it would involve implementation of a single approach to each property. In contrast, the Floodproofing Alternative, which includes some elevation or acquisition and demolition of buildings as well, would involve several different approaches that would present greater challenges in implementation.[9] It is concluded that implementation of each of the alternatives would present significant challenges, and there is no single alternative that would obviously be the most readily implemented.

---

[9]*MMSD has established a policy that it will pay for floodproofing a private building that is identified in a District watercourse system plan as being at risk of flooding if the property owner will grant the District a flood easement to ensure that the floodproofing measures are properly maintained.*

Effectiveness of Protection
The Acquisition Alternative would clearly offer the greatest degree of effectiveness in eliminating flood damages. If the buildings in the one-percent-probability floodplain are removed, they would no longer be subject to damages under any flooding conditions. Some potential for sanitary sewer inflow and infiltration would still exist unless the "islands" of buildings that are outside the one-percent-probability floodplain, as shown on Map 5, were also acquired and demolished and the streets providing access were abandoned. Such an approach would increase the cost of that alternative somewhat. Since the Acquisition Alternative is the most costly, the relative ranking of the alternative plans would be unchanged if those actions were taken.

Neither of the other two alternative plans would offer a comparable level of effectiveness, although their effectiveness would be improved through adherence to strict design standards. The Levee Alternative would be designed to protect the buildings in the floodplain during floods with probabilities of one-percent and greater, and to protect them during storms of similar probabilities occurring over the localized land areas on the protected side of the levees. However, during larger floods, or larger local storms, some, or all, of the "protected" buildings could be flooded. Such flooding could occur through overtopping or failure of the levees and/or through failure of the pump stations designed to pump stormwater runoff from the protected area to the River. The levee and pump station designs would include the following provisions to minimize those risks:

- The provision of three to four feet of freeboard between the one-percent-probability flood stage elevation and the tops of the levees,

- Structural design of the levees to meet State and FEMA standards, and

- The provision of backup pumping capacity for the pump stations.

Despite those design safeguards, the effectiveness of protection under the Levee Alternative would still be less than under the Acquisition Alternative.

The Floodproofing Alternative offers only a partial solution of the flooding problem because flooding of streets and adjacent lands and possible infiltration and inflow to sanitary sewers would still occur in the areas where buildings are floodproofed or elevated. In addition, because floodproofing and elevation measures may be applied by individual homeowners, and each case is somewhat different, it would be difficult to insure that all floodproofing and elevation measures would be completely effective.

Each of the alternative plans is designed to provide flood protection during events with annual probabilities of one percent or greater; however, during larger events, the degree of flood protection afforded by each alternative would vary. The Acquisition Alternative would afford the greatest degree of protection during larger flood events because removal of buildings would eliminate the hazard to those buildings. The Floodproofing Alternative would offer the next greatest degree of protection during floods larger than the design flood because it calls for significant numbers of buildings to be elevated or acquired and removed. Elevation would reduce the hazard during floods larger than the design flood, and, as noted previously, acquisition and demolition would eliminate the hazard. Depending on the floodproofing methods employed, during floods exceeding the design event the floodproofed buildings may, or may not, experience damages similar to those expected with no flood protection in place. Under the Levee Alternative, a flood in excess of the design flood could lead to levee failure that would eliminate the flood protection and could flood the protected area to a degree similar to that would occur if nothing had been done. In addition, flooding from a levee failure would occur more quickly than flooding from more gradually-rising River stages. Finally, failure of the interior drainage system with the levee remaining intact would afford no outlet for stormwater runoff to reach the River, possibly flooding buildings in the area to be protected.

It is concluded that, based on effectiveness of protection, the Acquisition Alternative (No. 1) is preferable.

Special Considerations Related to Levees

Considerable national attention has been focused on levee systems since the major 1993 floods in the Mississippi River basin, the 1997 floods in the California Central Valley, and the 2005 flooding in the City of New Orleans related to Hurricane Katrina. One of the issues raised by those floods is the appropriate level of flood protection for which levee systems should be designed. The issue of level of protection is addressed in a 2007 position paper issued by the Association of State Floodplain Managers (ASFPM).[10]

That position paper notes that, while in the past levees were designed for the Probable Maximum Flood, a 0.2-percent-annual-probability (500-year recurrence interval) flood, or perhaps an 0.5-percent-probability (200-year recurrence interval) flood, in more recent times roughly coinciding with the period since the inception of the National Flood Insurance Program (NFIP), levees have commonly been designed to withstand a one-percent-probability (100-year recurrence interval) flood. The ASFPM paper attributes application of that lower design standard to a combination of providing flood protection for the purpose of eliminating the requirement for Federal flood insurance under the FEMA NFIP and to application by the U.S. Army Corps of Engineers (USCOE) of the Congressionally-mandated National Economic Development policy for flood control projects.

Under current FEMA regulations, if a levee meets FEMA criteria, the FEMA digital flood insurance rate map will show the area on the landward side of the levee as a moderate risk zone that is protected from the one-percent-probability flood. Federal flood insurance would be encouraged, but not required in the protected area. As noted previously in this memorandum, there are special considerations unique to the areas protected by levees, including the possibility of flooding of protected areas resulting from levee or interior drainage system failure, either due to structural failure caused by conditions that were unforeseen during levee design, or during events larger than the design event.

Because of the critical nature of levees in providing flood protection, and because of the possibility that such protection can be compromised during events greater than that for which a levee is designed, the ASFPM position paper recommends that:

- "Congress and the Administration … adopt a policy that the 500-year level of protection for levee design is the minimal standard for purposes of flood insurance and other federal investment."
- "Levees … be used as a structure of last resort and only after other measures, especially nonstructural ones, have been fully considered."
- "The area that would be inundated when a levee fails or is overtopped, or when internal drainage systems are overwhelmed or incapacitated should be mapped as a residual risk flood hazard area and depicted on Flood Insurance Rate Maps."
- "The purchase of flood insurance and appropriate development standards should be mandatory for all property protected by levees, to reflect the potential for the catastrophic consequences of levee failure."

The Federal Interagency Levee Policy Review Committee[11] has made the following pertinent recommendations:

---

[10]*Association of State Floodplain Managers,* National Flood Policy Challenges, Levees: The Double-edged Sword, *February 13, 2007.*

[11]*Interagency Levee Policy Review Committee,* The National Levee Challenge – Levees and the FEMA Flood Map Modernization Initiative, *September 2006.*

- “FEMA should take immediate steps to examine the feasibility of not recognizing, for NFIP purposes, levees that protect highly urbanized areas unless they provide protection from events greater than 100-year floods(e.g., 500-year floods).”

- “FEMA should define, as a matter of policy, a new flood insurance zone (Zone XL) for areas behind levees that meet the requirements for inclusion in the NFIP. Zone XL would include those areas behind the levee that would be subject to inundation by the 100-year flood if there were no levee.”[12]

Although, with the exception noted in the footnote to the preceding paragraph, these recommendations have not been adopted as a whole or in part at the Federal level, it is likely that they will be given serious consideration as the Federal and state governments work toward establishment of a National Levee Safety Program (as authorized under the National Levee Safety Act, which is part of the 2007 U.S. Water Resources Development Act) and as Congress explores issues related to the connection between USCOE levee programs and the FEMA levee certification program.

As described previously, consistent with MMSD policy, this watercourse system plan is formulated to provide flood protection during floods with annual probabilities of one percent or more. Although the alternative plans were developed to meet that criterion, in light of the foregoing description of recent initiatives related to the level of protection for levees, the following brief discussion is provided on the possible effects on the relative costs of expanding each alternative to provide protection during a 0.2-percent-probability flood. As seen from Table 3, during a 0.2-percent-annual-probability flood, it is anticipated that about 75 percent more buildings could be flooded than during a one-percent-probability flood. The additional cost of expanding the Acquisition Alternative to include buildings within the 0.2-percent-probability floodplain would be roughly proportional to the additional number of buildings affected, or a 75 percent increase. The additional cost of expanding the Floodproofing Alternative would likely be somewhat more than 75 percent, because, in addition to providing flood protection for the additional flooded buildings, some buildings that would be floodproofed under a plan for protection during a one-percent-probability flood would need to be elevated and some buildings that were to be elevated would have to be acquired and demolished.[13] However, because that alternative plan is considerably less costly than the other two alternatives, the relative ranking by cost of the Floodproofing Alternative would not be expected to change. The additional cost of expanding the Levee Alternative would be attributable to raising and lengthening levees, possibly purchasing more buildings along the levee alignment, and upgrading interior drainage facilities to accommodate runoff from a 0.2-percent-probability storm. It is likely that its adjusted cost would still fall between the costs of the Acquisition and Floodproofing Alternatives. Thus, revising the alternative plans to accommodate a 0.2-percent-probability design event would not be expected to significantly change the relative cost relationship among the alternatives.

COORDINATION WITH THE CITY OF GLENDALE

October 6, 2009 Intergovernmental Meeting

Because the great majority of flood damages from overflow of the Milwaukee River would be expected to occur in the City of Glendale, the MMSD arranged a meeting to review a preliminary draft of this report with the Mayor

---

[12]*While FEMA has not adopted this recommendation as stated, under Procedure Memorandum No. 45,* Revisions to Accredited Levee and Provisionally Accredited Levee Notation, *it has ordered that, for accredited levee systems, the protected area landward of the levee continue to designated as Zone X with a note stating in part.*

“This area is shown as being protected from the 1-percent-annual-chance or greater flood hazard by a levee system. Overtopping of any levee system is possible.”

[13]*As seen from Table B-2 in Appendix B of this memorandum, the difference in flood stage elevation between a one-percent- and a 0.2-percent- probability event is about two feet.*

and City staff that was held on October 6, 2009. Those in attendance included Mayor Jerome Tepper; John Fuchs, City Attorney, Collin Johnson, City Director of Inspection Services, Richard Maslowski, City Administrator, and Todd Stuebe, City Director of Community Development; Michael Martin, MMSD Director of Technical Services; and Thomas Chapman, MMSD Watercourse Section Manager; and Michael Hahn, SEWRPC Chief Environmental Engineer.

Following that meeting, Mr. Maslowski summarized the salient points from the meeting in his October 14, 2009 letter to Mr. Martin and Mr. Hahn. That letter is attached to this report as Appendix C. The preliminary draft report that was reviewed at the October 2009 meeting included descriptions and assessment of positives and negatives of each of the three alternatives, but it did not include selection of a preliminary recommendation, instead noting that, in addition to the issues addressed in the alternatives evaluation in the preliminary draft report, the selection of a recommended plan that should be carried forward by MMSD for preliminary engineering followed by final design would depend on a number of factors, including:

- Local community preferences as expressed during the public information period,
- Property owner preferences as expressed during the public information period, and
- Input from the MMSD Commission and staff.

Thus, all three alternatives were open for consideration at the meeting.

The main points of Mr. Maslowski's letter, and SEWRPC staff responses, are provided below:

- **CITY COMMENT:** "As discussed, the City of Glendale has serious concerns regarding the alternative referenced, requiring the acquisition of 384 homes in Glendale. If this were to occur, it would represent the elimination of 8% of the City's existing single family housing and 7.6% of the City's housing value, based upon January 1, 2009 Wisconsin Department of Revenue data. Utilizing that same database, the annual tax loss for Glendale would be in excess of $2,038,000, or approximately 5% of the City's total tax levy. The specific impact on the City's utilities (water sanitary and storm) has not been calculated, nor has the potential fiscal impact on the City's K-8 school district (Glendale-River Hills) or Nicolet High School."

  SEWRPC STAFF RESPONSE: The fiscal information provided by the City is an important consideration in evaluating the alternative plans. That information, in combination with 1) the City's preference to proceed with limited acquisition of houses in combination with a residential floodproofing program within the one-percent-annual-probability floodplain, as described in Mr. Maslowski's October 2009 letter, and set forth below, and 2) the relatively high cost and lower benefit-cost ratio of Alternative No. 1 provide justification for removing that alternative from further consideration.

- **CITY COMMENT:** "Regarding the 1997 referenced flood, you will find enclosed the flood report as submitted to the Federal Emergency Management Agency in October of that year [see Appendix C]. The report indicates there were no major residential damages and 128 minor residential damages."

- **SEWRPC STAFF RESPONSE:** The "Historical Flooding Information" section of this report has been revised to include the information on the 1997 flood provided by the City and to omit information reported in the July 10, 1997, edition of the Milwaukee Journal Sentinel, which was included in the preliminary draft, and which the City staff characterized as inaccurate.

- **CITY COMMENT:** "Also, as discussed at our meeting, the City of Glendale would be willing to work with the Regional Planning Commission and MMSD to develop a fully funded voluntary residential acquisition program for the area referred to as the Sunny Point Peninsula in the draft report. It is these homes located within this area that have regular ongoing flooding related issues and costs.

In addition, the City would be willing to work with the Regional Planning Commission and MMSD to develop and implement a fully funded residential flood-proofing program for structures located within the designated 100 year flood plain area. We believe that a fully funded program, together with a properly designed educational program for residential property owners could, in a period of time, result in the desired efforts mentioned as Alternative #2 in the report."

SEWRPC STAFF RESPONSE: The approach proposed by the City represents an appropriate local refinement for phased implementation of Alternative No. 2, Floodproofing, Elevation, or Acquisition and Demolition of Buildings in the One-Percent-Annual-Probability Floodplain. Based on Alternative No. 2 having the lowest cost of the three alternative plans, the highest benefit-cost ratio, and the stated preference of the City staff, Alternative No. 2 is selected as the preliminary recommended plan, subject to public comments on the plan, and input from the MMSD Commission and staff.

The MMSD policy regarding floodproofing of private buildings allows MMSD to pay the cost of floodproofing when it is less than acquisition and demolition if the property owner places a restriction on the deed of the property which allows MMSD to periodically inspect the floodproofing measures to be sure they are functioning as intended.

July 29, 2010 Intergovernmental Meeting

A revised preliminary draft of this report was issued in May 2010 and was provided to MMSD and the City of Glendale for review. In a June 24, 2010 letter to Kevin L. Shafer, MMSD Executive Director, and Kenneth R. Yunker, SEWRPC Executive Director, Mr. Maslowski requested another meeting between the staffs of the City, MMSD, and SEWRPC. That meeting was held on July 29, 2010. Those in attendance included Mayor Jerome Tepper; John Fuchs, City Attorney, Collin Johnson, City Director of Inspection Services, Richard Maslowski, City Administrator, and Todd Stuebe, City Director of Community Development; Kevin Shafer, MMSD Executive Director, Michael Martin, MMSD Director of Technical Services, and Thomas Chapman, MMSD Watercourse Section Manager; and Kenneth Yunker, SEWRPC Executive Director, and Michael Hahn, SEWRPC Chief Environmental Engineer. The City's concerns with specific aspects of the preliminary draft report were discussed at the meeting, and the City requested that SEWRPC provide a letter summarizing the flood mitigation recommendations pertinent to the City.

Following the meeting, the SEWRPC staff summarized the specific preliminary recommended plan in an August 5, 2010 letter to Mr. Maslowski, with copies provided to the MMSD staff. That letter is attached to this report as Appendix D. Mr. Maslowski's August 17, 2010 response to the SEWRPC letter is also included in Appendix D.

The main points of Mr. Maslowski's letter are:

- The City supports a fully-funded voluntary program to:
    - Acquire 19 residences within the Sunny Point Peninsula,
    - Floodproof or elevate other buildings within the one-percent-annual-probability floodplain
- The City is "very concerned as to the possible number of properties that might be identified for potential acquisition outside the Sunny Point Peninsula area."
- The City understands that an "MMSD program for floodproofing, elevation changes and possible acquisition would require a restriction on the deed of the property regarding future inspections, and future uses of land if acquired."

The points raised in Mr. Maslowski's August 2010 letter are generally consistent with the description of the preliminary recommended plan set forth in the August 2010 SEWRPC letter and with the final recommended plan described later in this report. The SEWRPC letter and the final recommended plan raise the possibility of minimizing the need for building acquisitions by relaxing the maximum building elevation criterion on a case-by-case basis.

POSSIBLE STUDY TO ADDRESS FLOODING PROBLEMS ALONG THE MAINSTEM OF THE MILWAUKEE RIVER WITHIN, AND UPSTREAM FROM, MILWAUKEE COUNTY

Since the flood control jurisdiction of the MMSD along the mainstem of the Milwaukee River is limited to Milwaukee County, the study documented in this report only addresses that reach of the River. As noted previously in the section of this report describing the Milwaukee River mainstem flood analyses set forth in the 1971 SEWRPC Milwaukee River watershed study, there is also a flood hazard in the City of Mequon and the Villages of Saukville and Thiensville in Ozaukee County. Thus, an updated approach to addressing the entire Milwaukee River mainstem flooding problems may have merit from both technical and cost effectiveness standpoints. The possibility of applying such an approach has been raised by the MMSD staff.

The 1971 Milwaukee River watershed study recommended a nonstructural floodproofing and acquisition approach to addressing mainstem flooding problems, similar to the preliminary recommendation set forth herein; however, other nonstructural alternatives, including levee/floodwall systems, floodwater diversion to Lake Michigan,[14] and flood control reservoirs were also developed and evaluated. The rationales for rejecting floodwater diversion and reservoir storage at the time the Milwaukee River watershed study was developed are described in the section of this memorandum report entitled "Analysis of Alternative Floodland Management Plans for the Milwaukee River." Ozaukee County is in the process of implementing a project to improve fish passage throughout the Milwaukee River watershed within the County, including selective removal of dams and construction of fish passage facilities. Thus, the online flood control reservoir that was rejected in 1971 would be even less feasible or desirable today. There may be opportunities to provide off-line storage, but given the relatively small flood control benefits from the large reservoir considered in 1971, it is questionable whether effective off-line storage could be provided. In the almost 40 years that have passed since 1971, there has likely been development along the route of the floodwater diversion to Lake Michigan that was considered and rejected under the watershed study. While such an approach may hold more promise from a flood mitigation perspective, it would also be likely to pose environmental challenges.

If the municipalities in Ozaukee County that are affected by flooding from the Milwaukee River mainstem have sufficient interest in conducting a study of alternative structural means of addressing both the flooding in Ozaukee County and the identified flooding problems in Milwaukee County, the MMSD Commission could consider contributing funding to such a study. If MMSD decided to consider pursuing such a study, the SEWRPC staff would work with MMSD and the affected municipalities in Ozaukee County to determine the level of interest in forming a coalition to participate in and fund a study.

RECOMMENDED WATERCOURSE SYSTEM PLAN

The three alternative plans were evaluated on the basis of cost, implementability, effectiveness of protection, special considerations related to levee systems, and local preferences as stated by the City of Glendale. On the basis of those factors, Alternative No. 2, Floodproofing, Elevation, or Acquisition and Demolition of Buildings in the One-Percent-Annual-Probability Floodplain is selected as the recommended plan.

---

[14] *This approach was initially developed in 1964 by the U.S. Army Corps of Engineers, and was subsequently incorporated in the Milwaukee River watershed study.*

The plan components in each affected municipality (the Cities of Glendale and Milwaukee and the Villages of Brown Deer and River Hills) and estimated capital and operation and maintenance costs are set forth in Table 10. Under the recommended plan, in the City of Glendale, 138 buildings would be floodproofed, 176 buildings would be elevated, and 70 buildings would be purchased and demolished and removed from the floodplain. Three buildings in the City of Milwaukee, and three buildings in the Village of Brown Deer, would be floodproofed. In the Village of River Hills, one building would be floodproofed, one would be elevated, and one would be acquired and demolished. Implementation of the recommended plan by MMSD, in cooperation with the affected municipalities, would be on a strictly voluntary basis with recommended measures on private property only being instituted with the consent of the owner. The open space that would be created in areas where buildings would be removed would remain in public ownership and would be prohibited from future development with inhabited structures. The approximate extents of the areas in which buildings would be floodproofed, elevated, or purchased in the City of Glendale are shown on Map 8.

As set forth in Table 10, the estimated costs are 1) $2.5 million to floodproof 145 buildings, 2) $15.9 million to elevate 177 buildings, and 3) $19.8 million to acquire and demolish 71 buildings, yielding a total capital cost of $38.2 million.

Under the alternative plans and the recommended plan, it was assumed that structures designated to be elevated would be raised two feet above the one-percent-probability flood stage, and that the maximum structure elevation height would be four feet above grade. If a structure would have to be elevated more than four feet to achieve the desired two feet of freeboard above the design flood stage, it was assumed that the structure would be purchased and demolished. However, as noted by the SEWRPC staff during the July 2010 intergovernmental meeting and in the August 5, 2010 letter to the City of Glendale, the building elevation criterion could be revised on a case-by-case basis to allow buildings to be elevated more than a total of four feet, potentially reducing the number of buildings to be acquired and demolished. If affected buildings are clustered on contiguous lots, raising buildings above the four-foot maximum criterion might be possible while still achieving an aesthetically acceptable effect and providing adequate stormwater drainage. In some cases, the ability to elevate buildings may be limited by site-specific constraints such as the location and nature of the garage and the ability to adequately place fill adjacent to the foundation.

As noted previously in this report in the section addressing the City of Glendale’s October 14, 2009 letter (reproduced in Appendix C), a fully MMSD-funded, voluntary residential acquisition program for the Sunny Point Peninsula area in the City of Glendale and a cooperative program involving the City of Glendale, MMSD, and SEWRPC to develop and implement a fully MMSD-funded residential floodproofing program for structures located within the designated one-percent-annual-probability (100-year recurrence interval) floodplain, and for which effective floodproofing is possible, represents an appropriate locally-proposed refinement for phased implementation of the recommended plan. Since the plan has the overriding objective of mitigating flood damages during events with annual probabilities of one-percent or greater (floods less than or equal to the 100-year recurrence interval flood), the plan recommendations must comprehensively address that flooding condition, leaving no flood hazard areas without mitigation. Thus, full implementation of the recommended plan would still involve acquisition, demolition, and removal of up to 71 structures; however, the number of buildings to be acquired, demolished, and removed might be reduced as described in the preceding paragraph.

The MMSD policy regarding floodproofing of private buildings allows MMSD to pay the cost of floodproofing, subject to approval of that payment by the MMSD Commission, when that cost is less than acquisition and demolition, if the property owner places a restriction on the deed of the property which allows MMSD to periodically inspect the floodproofing measures to be sure they are functioning as intended. MMSD considers building elevation to be a form of floodproofing, thus, this policy would also apply to building elevation. MMSD also has traditionally paid for building acquisition, demolition, and removal when recommended under an adopted watercourse system plan. Thus, the City of Glendale’s desire for a fully MMSD-funded program could be met if the deed restrictions could be obtained for floodproofing and elevation of private buildings.

SEWRPC Memorandum Report No. 172

A WATERCOURSE SYSTEM PLAN FOR THE MILWAUKEE RIVER IN MILWAUKEE COUNTY UPSTREAM OF THE MILWAUKEE HARBOR ESTUARY

TABLES

(This Page Left Blank Intentionally)

Table 1

SIGNIFICANT HISTORICAL FLOODS ON THE MILWAUKEE RIVER AT USGS GAGE NO. 04087000 NEAR ESTABROOK PARK: 1915-2008[a]

Date of Occurrence of Flood Peak	Peak Flood Flow (cfs)	Estimated Annual Probability of Occurrence of Peak Flood Flow (percent)	Estimated Recurrence Interval of Peak Flood Flow (years)
03/20/1918	15,100	0.8	125
08/06/1924	15,100	0.8	125
03/15/1929	11,000	4.0	25
04/03/1959	8,780	10.0	10
03/31/1960	9,300	8.0	12
04/21/1973	12,600	2.0	50
07/21/1997	16,500	0.5	200
06/07/2008	10,300	5.0	20

[a]*Floods with annual probabilities less than 10 percent (recurrence intervals greater than 10 years) are listed here.*

Source: U.S. Geological Survey and SEWRPC.

Table 2

CATEGORIES OF FLOOD LOSSES AND RISKS

Type of Damage	Ownership	
	Private Sector	Public Sector
Direct	Cost of cleaning, repairing, or replacing residential, commercial, and industrial buildings, contents, and land Cost of cleaning, repairing, or replacing agricultural buildings and contents and cost of lost crops and livestock	Cost of repairing or replacing road segments, bridges, culverts, and dams Cost of repairing damage to stormwater systems, sanitary sewerage systems, and other utilities Cost of restoring parks and other public recreational lands
Indirect	Cost of temporary evacuation and relocation Lost wages Lost production and sales Incremental cost of transportation Cost of post-flood floodproofing[a]	Incremental costs to governmental units as a result of flood fighting measures Cost of post-flood engineering and planning studies
Intangible	Loss of life Health hazards Psychological stress Reluctance by individuals to inhabit floodprone areas, thereby depreciating riverine area property values	Disruption of normal community activities Reluctance by business interest to continue development of floodprone commercial-industrial areas, thereby adversely affecting the community tax base

[a]*Would be paid by MMSD if property owner grants an easement to ensure proper maintenance.*

Source: SEWRPC.

Table 3

INVENTORY OF BUILDINGS WITHIN 10- THROUGH 0.2-PERCENT-ANNUAL-PROBABILITY FLOODPLAINS

	Number of Buildings Located within:											
	10-Percent-Annual-Probability Floodplain			Two-Percent-Annual-Probability Floodplain			One-Percent-Annual-Probability Floodplain			0.2-Percent-Annual-Probability Floodplain		
Municipality	Commercial	Recreational	Residential	Commercial	Recreational	Residential	Commercial	Recreational	Residential	Commercial	Recreational	Residential
City of Glendale	1	0	72	1	0	251	1	0	383	1	0	603
City of Milwaukee..........	0	0	0	0	0	0	0	0	3	0	0	69
Village of Brown Deer	0	0	0	0	0	1	0	0	3	0	0	4
Village of River Hills	0	0	1	0	1	2	0	1	2[a]	0	1	6
TOTAL	**1**	**0**	**73**	**1**	**1**	**254**	**1**	**1**	**391**	**1**	**1**	**682**

[a]*There are two additional buildings in the Village of River Hills that are located near the one-percent-annual-probability floodplain boundary. Field surveys would be needed to determine whether the structures are within that floodplain.*

Source: SEWRPC.

Table 4

MILWAUKEE RIVER MAINSTEM IN MILWAUKEE COUNTY – TOTAL FLOOD DAMAGES

Municipality	10-Percent-Annual-Probability (100-year recurrence interval) Total Flood Damages	Two-Percent-Annual-Probability (100-year recurrence interval) Total Flood Damages	One-Percent-Annual-Probability (100-year recurrence interval) Total Flood Damages	0.2-Percent-Annual-Probability (500-year recurrence interval) Total Flood Damages
City of Glendale..............	$1,480,000	$7,490,000	$12,520,000	$26,420,000
City of Milwaukee	0	0	50,000	1,820,000
Village of Brown Deer......	0	3,000	60,000	110,000
Village of River Hills	29,000	130,000	170,000	560,000
TOTAL	**$1,509,000**	**$7,623,000**	**$12,800,000**	**$28,910,000**

Source: SEWRPC.

Table 5

MILWAUKEE RIVER MAINSTEM IN MILWAUKEE COUNTY – AVERAGE ANNUAL FLOOD DAMAGES

Municipality	Average Annual Flood Damages
City of Glendale......................	$650,000
City of Milwaukee...................	11,000
Village of Brown Deer	1,200
Village of River Hills	12,000
TOTAL	**$674,200**

Source: SEWRPC.

Table 6

MILWAUKEE RIVER MAINSTEM IN MILWAUKEE COUNTY – COST ANALYSIS ALTERNATIVE NO. 1 – ACQUISITION AND DEMOLITION OF BUILDINGS IN THE ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAIN

Municipality	Number of Properties to Be Acquired and Demolished	Acquisition Cost[a]	Average Annual Cost[b]	Average Annual Benefits	Benefit-Cost Ratio
City of Glendale..............	384	$103,600,000	$6,600,000	$570,000[c]	0.086
City of Milwaukee	3	800,000	50,000	200	0.004
Village of Brown Deer......	3	900,000	60,000	1,000	0.017
Village of River Hills.........	3	2,300,000	150,000	10,000	0.067
TOTAL	**393**	**$107,600,000**	**$6,860,000**	**$581,200**	**0.085**

[a]*Based on year 2006 or 2007 fair market value of improvements and land plus $45,000 per residential structure, and $80,000 per commercial structure, for demolition, relocation assistance, moving expenses, title insurance, closing costs, appraisal, surveys, property taxes, and miscellaneous fees.*

[b]*Amortized capital cost is based on an interest rate of 6 percent and a project life of 50 years.*

[c]*Equal to the average annual flood damages avoided during a one-percent-annual-probability flood through removal of the 384 buildings in the one-percent floodplain plus an estimate of the proportion of the incremental damages between a one-percent-probability event and the total damages (with total damages including floods with probabilities of less than one percent) that would be avoided through demolition of those 384 buildings.*

Source: SEWRPC.

Table 7

MILWAUKEE RIVER MAINSTEM IN MILWAUKEE COUNTY – COST ANALYSIS
ALTERNATIVE NO. 2 – FLOODPROOFING, ELEVATION, OR ACQUISITION AND DEMOLITION OF BUILDINGS
IN THE ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAIN

Municipality	Number of Buildings to Be Floodproofed	Floodproofing Cost[a]	Number of Buildings to Be Elevated	Elevation Cost[b]	Number of Buildings to Be Acquired and Demolished	Acquisition Cost[c]	Total Capital Cost for Structure Floodproofing, Elevation, or Acquisition and Demolition	Average Annual Cost[d]	Average Annual Benefits	Benefit-Cost Ratio
City of Glendale	138	$2,400,000	176	$15,800,000	70	$19,500,000	$37,700,000	$2,400,000	$450,000 [e]	0.19
City of Milwaukee..........	3	50,000	- -	- -	- -	- -	50,000	3,000	200	0.07
Village of Brown Deer	3	50,000	- -	- -	- -	- -	50,000	3,000	300	0.10
Village of River Hills.......	1	20,000	1	90,000	1	300,000	410,000	30,000	9,000	0.30
TOTAL	**145**	**$2,520,000**	**177**	**$15,890,000**	**71**	**$19,800,000**	**$38,210,000**	**$2,436,000**	**$459,500**	**0.19**

[a]*Single-family house: $17,000. Industrial. commercial building: Fair market value x (0.07 + 0.05 x height, in feet, of floodproofing above first floor).*

[b]*$90,000 per single-family house.*

[c]*Based on year 2006 or 2007 fair market value of improvements and land plus $45,000 per residential structure, and $80,000 per commercial structure, for demolition, relocation assistance, moving expenses, title insurance, closing costs, appraisal, surveys, property taxes, and miscellaneous fees.*

[d]*Amortized capital cost is based on an interest rate of 6 percent and a project life of 50 years.*

[e]*Equal to the average annual flood damages avoided during a one-percent-annual-probability flood through removal of 70 buildings in the one-percent floodplain plus an estimate of the proportion of the incremental damages between a one-percent-probability event and the total damages (with total damages including floods with probabilities of less than one percent) that would be avoided through demolition of those 70 buildings.*

Source: SEWRPC.

Table 8

MILWAUKEE RIVER MAINSTEM IN MILWAUKEE COUNTY – COST ANALYSIS ALTERNATIVE NO. 3 – LEVEE FOR PROTECTION FROM THE ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOOD WITH FLOODPROOFING OR ACQUISITION AND DEMOLITION OF SELECTED BUILDINGS

Municipality	Number of Buildings that Would Be Protected By Levees During the One-Percent-Annual-Probability (100-year recurrence interval) Flood	Number of Buildings Located Riverward of Levees that Would Be Acquired and Demolished	Number of Buildings Located Along or Near the Levee Alignments that Would Be Acquired and Demolished	Number of Buildings to Be Floodproofed	Number of Buildings in the Floodplain to Be Acquired and Demolished	Number of Buildings to be Elevated	Capital Cost of Levee Construction	Acquisition and Demolition Cost for Levee Construction	Capital Cost of Interior Drainage Facilities	Land Acquisition Cost for Levees (other than for acquisition of buildings and land for demolition)
City of Glendale	287	39	71	- -	- -	- -	$5,000,000	$21,300,000	$22,500,000	$1,000,000
City of Milwaukee.........	- -	- -	- -	3	- -	- -	- -	- -	- -	- -
Village of Brown Deer ..	- -	- -	- -	3	- -	- -	- -	- -	- -	- -
Village of River Hills.....	- -	- -	- -	1	1	1	- -	- -	- -	- -
TOTAL	**287**	**39**	**71**	**7**	**1**	**1**	**$5,000,000**	**$21,300,000**	**$22,500,000**	**$1,000,000**

Municipality	Acquisition and Demolition Cost for Properties Riverward of the Levees	Floodproofing Cost	Acquisition and Demolition Cost	Elevation Cost	Total Capital Cost	Annual Levee O & M	Annual Pump Station O&M	Total Annual O & M	Average Annual Cost	Average Annual Benefits	Benefit-Cost Ratio
City of Glendale	$10,900,000	- -	- -	- -	$60,700,000	$40,000	$140,000	$180,000	$4,030,000	$594,000[a]	0.15
City of Milwaukee.........	- -	$ 50,000	- -	- -	50,000	- -	- -	- -	3,000	200	0.07
Village of Brown Deer ..	- -	50,000	- -	- -	50,000	- -	- -	- -	3,000	300	0.10
Village of River Hills.....	- -	20,000	$300,000	$90,000	410,000	- -	- -	- -	30,000	9,000	0.30
TOTAL	**$10,900,000**	**$120,000**	**$300,000**	**$90,000**	**$61,210,000**	**$40,000**	**$140,000**	**$180,000**	**$4,066,000**	**$603,500**	**0.15**

NOTES: Capital construction costs based upon year 2008 conditions, Engineering News-Record Construction Cost Index = 10,520.

Building fair market values are for year 2006 or 2007.

[a]*Estimated as being equal to damages during a 0.2-percent-annual-probability (500-year recurrence interval) flood which would be avoided under this alternative since flood control levees are required by State and Federal law to be constructed to at least the 0.2-percent-annual-probability flood elevation.*

Source: SEWRPC.

Table 9

COMPARISON OF ESTIMATED COSTS OF ALTERNATIVE PLANS

Alternative	Total Capital Cost	Annual Operation and Maintenance	Average Annual Cost[a]	Average Annual Benefit	Benefit-Cost Ratio
Alternative No. 1 – Acquisition and Demolition of Buildings in the One-Percent-Annual-Probability (100-Year Recurrence Interval) Floodplain	$107,600,000	- -	$6,860,000	$581,200	0.08
Alternative No. 2 – Floodproofing, Elevation, or Acquisition and Demolition of Buildings in the One-Percent-Annual-Probability (100-Year Recurrence Interval) Floodplain	$ 38,210,000	- -	$2,436,000	$459,500	0.19
Alternative No. 3 – Levee for Protection from the One-Percent-Annual-Probability (100-Year Recurrence Interval) Flood with Floodproofing or Acquisition and Demolition of Selected Buildings	$ 61,210,000	$180,000	$4,066,000	$603,500[b]	0.15
Alternative No. 4 – No Action	- -	- -	$ 674,200[c]	- -	- -

[a]*Amortized capital cost is based on an interest rate of 6 percent and a project life of 50 years.*

[b]*The benefits accruing to implementation of Alternative No. 3 would be expected to exceed those for Alternative No. 1, because, in addition to providing protection up to a 0.2-percent-annual-probability flood for all buildings within the one-percent-annual-probability floodplain (by meeting the State and Federal requirement for levees to have freeboard to at least the 0.2-percent flood stage), Alternative No. 3 would also provide protection up to a 0.2-percent-probability flood for buildings within the 0.2-percent floodplain, but outside the one-percent floodplain. Those buildings outside the one-percent floodplain but within the 0.2-percent floodplain would not be protected under Alternative No. 1.*

[c]*Equal to average annual damages.*

Source: SEWRPC.

Table 10

COMPONENTS AND COSTS OF THE RECOMMENDED WATERCOURSE SYSTEM PLAN FOR THE MILWAUKEE RIVER MAINSTEM IN MILWAUKEE COUNTY FLOODPROOFING, ELEVATION, OR ACQUISITION AND DEMOLITION OF BUILDINGS IN THE ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAIN

Municipality	Number of Buildings to Be Floodproofed	Floodproofing Cost[a]	Number of Buildings to Be Elevated	Elevation Cost[b]	Number of Buildings to Be Acquired and Demolished	Acquisition Cost[c]	Total Capital Cost for Structure Floodproofing, Elevation, or Acquisition and Demolition
City of Glendale	138	$2,400,000	176	$15,800,000	70	$19,500,000	$37,700,000
City of Milwaukee..........	3	50,000	- -	- -	- -	- -	50,000
Village of Brown Deer	3	50,000	- -	- -	- -	- -	50,000
Village of River Hills.......	1	20,000	1	90,000	1	300,000	410,000
TOTAL	**145**	**$2,520,000**	**177**	**$15,890,000**	**71**	**$19,800,000**	**$38,210,000**

[a] *Single-family house: $17,000. Industrial. commercial building: Fair market value x (0.07 + 0.05 x height, in feet, of floodproofing above first floor).*

[b] *$90,000 per single-family house.*

[c] *Based on year 2006 or 2007 fair market value of improvements and land plus $45,000 per residential structure, and $80,000 per commercial structure, for demolition, relocation assistance, moving expenses, title insurance, closing costs, appraisal, surveys, property taxes, and miscellaneous fees.*

[d] *Amortized capital cost is based on an interest rate of 6 percent and a project life of 50 years.*

[e] *Equal to the average annual flood damages avoided during a one-percent-annual-probability flood through removal of 70 buildings in the one-percent floodplain plus an estimate of the proportion of the incremental damages between a one-percent-probability event and the total damages (with total damages including floods with probabilities of less than one percent) that would be avoided through demolition of those 70 buildings.*

Source: SEWRPC.

(This Page Left Blank Intentionally)

SEWRPC Memorandum Report No. 172

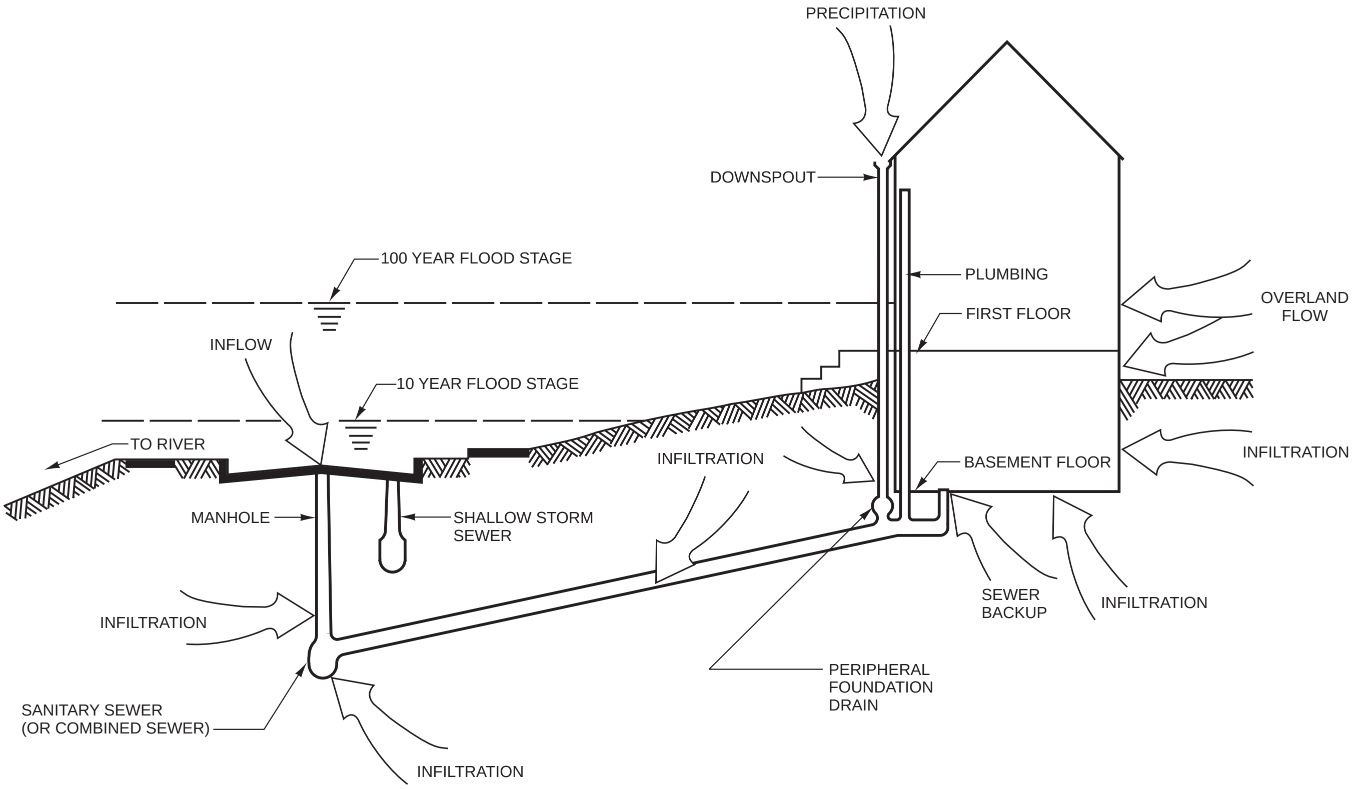
A WATERCOURSE SYSTEM PLAN FOR THE MILWAUKEE RIVER IN MILWAUKEE COUNTY UPSTREAM OF THE MILWAUKEE HARBOR ESTUARY

FIGURES

(This Page Left Blank Intentionally)

Figure 1

MEANS BY WHICH FLOODWATER MAY ENTER A STRUCTURE

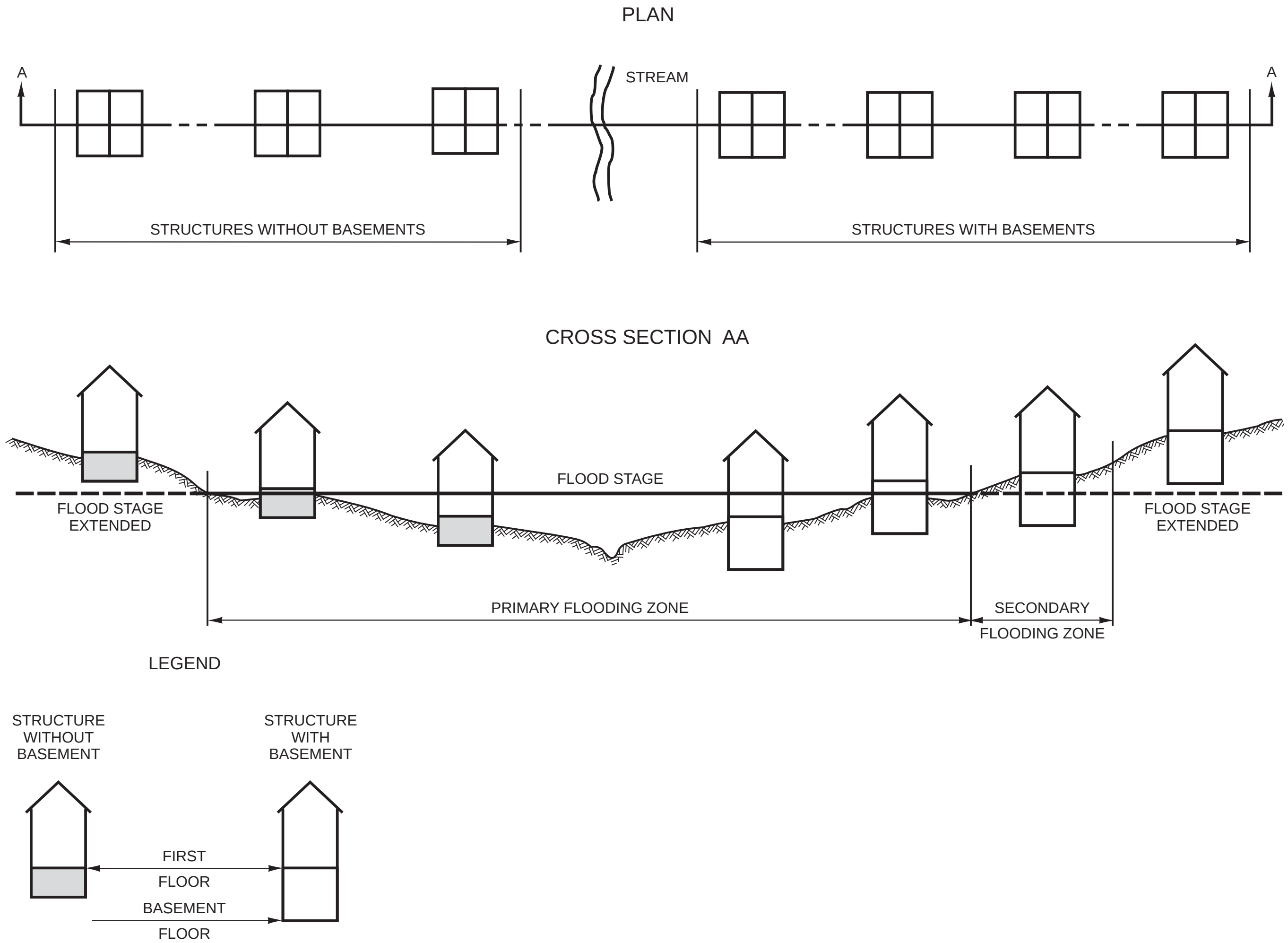


NOTE: TYPICAL AND GENERALLY PREFERABLE VARIATIONS INCLUDE DOWNSPOUTS DISCHARGING TO THE GROUND SURFACE AND FOUNDATION DRAINS CONNECTED TO STORM SEWERS OR CONNECTED TO A SUMP FROM WHICH WATER IS PUMPED TO THE GROUND SURFACE AT SOME POINT AWAY FROM THE STRUCTURE.

Source: SEWRPC.

Figure 2

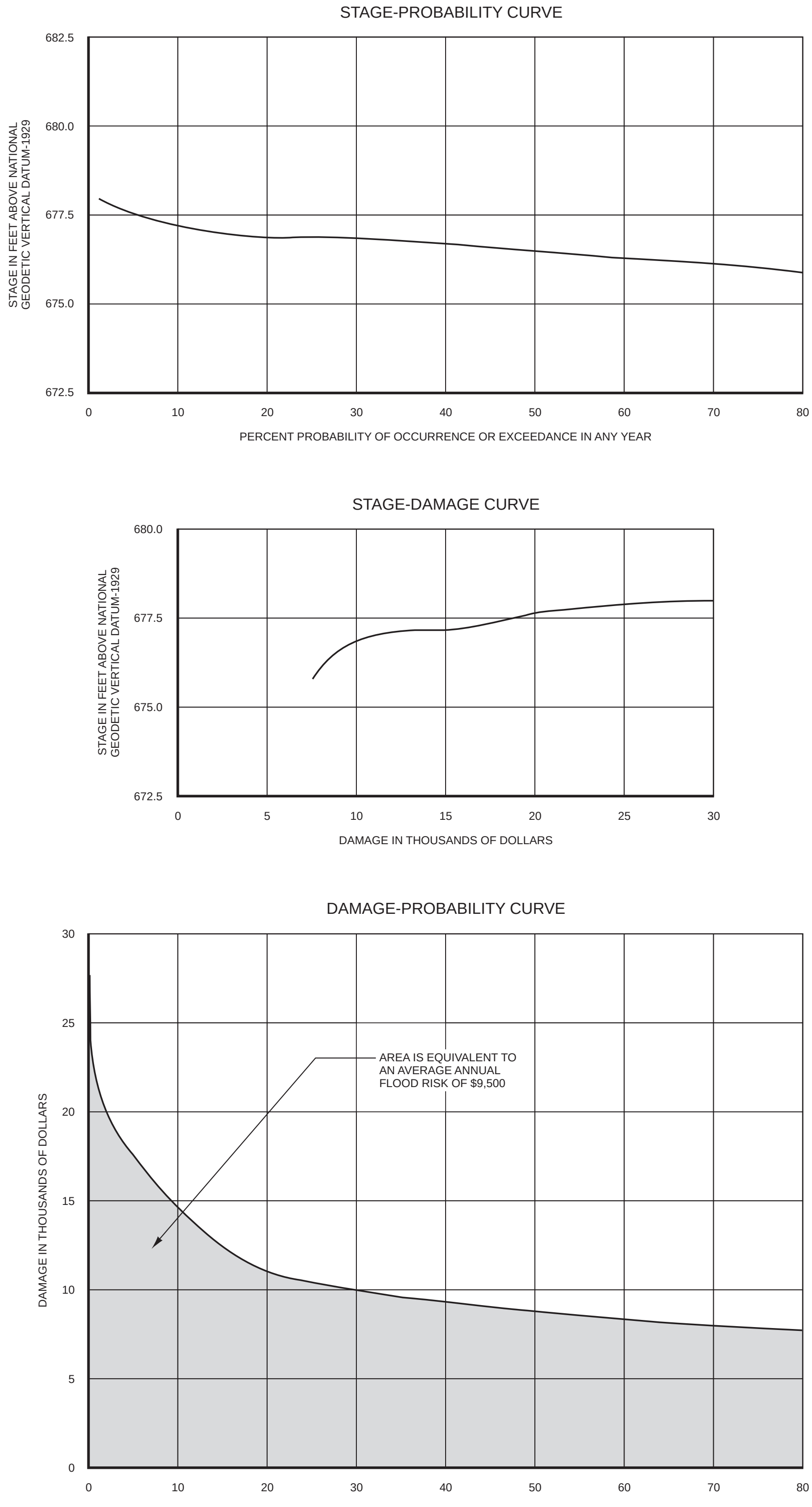
PRIMARY AND SECONDARY FLOOD ZONES



Source: SEWRPC.

Figure 3

EXAMPLE OF DETERMINATION OF AVERAGE ANNUAL FLOOD RISK FOR A HYPOTHETICAL REACH



Source: SEWRPC.

(This Page Left Blank Intentionally)

SEWRPC Memorandum Report No. 172

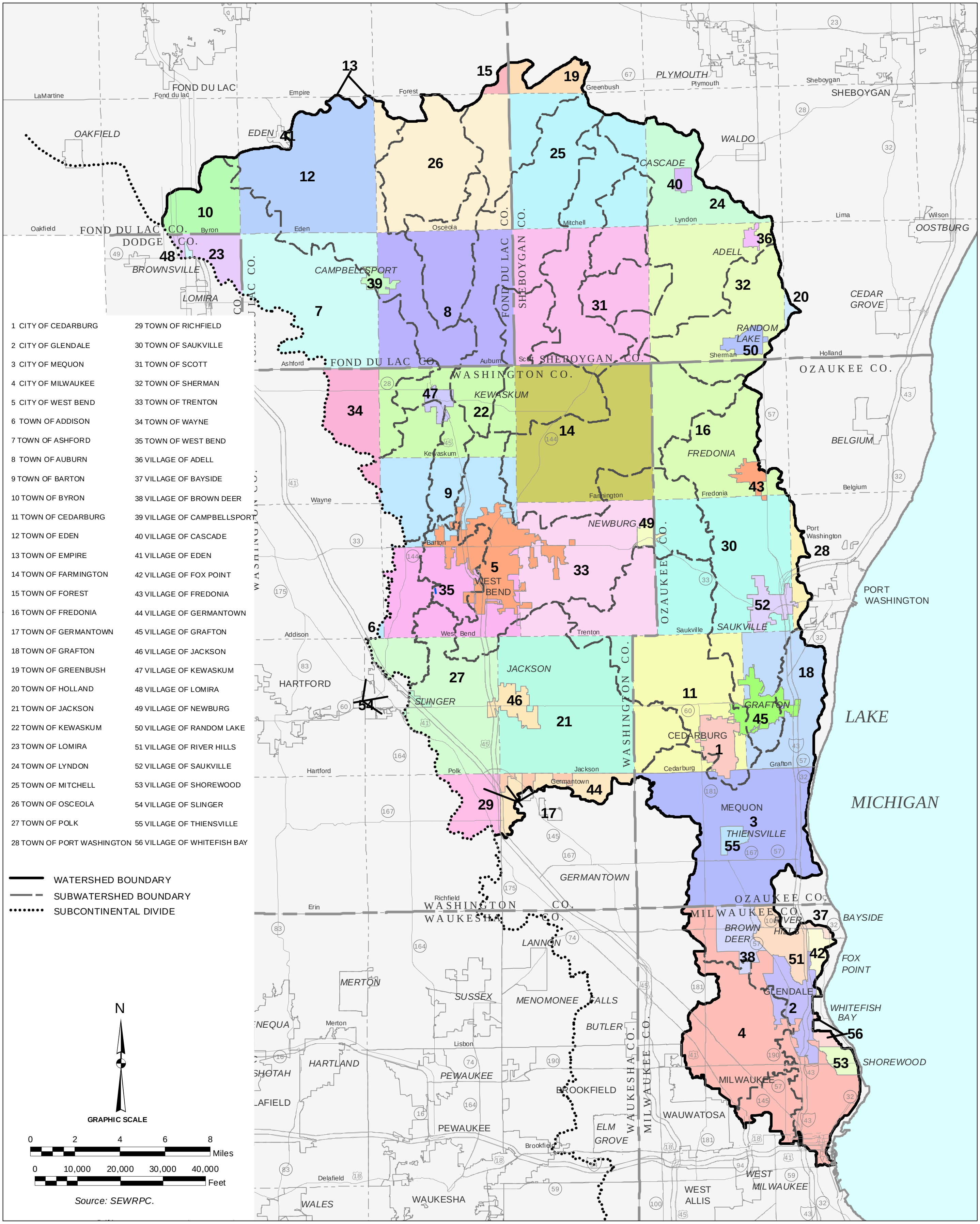
A WATERCOURSE SYSTEM PLAN FOR THE MILWAUKEE RIVER IN MILWAUKEE COUNTY UPSTREAM OF THE MILWAUKEE HARBOR ESTUARY

MAPS

(This Page Left Blank Intentionally)

Map 1

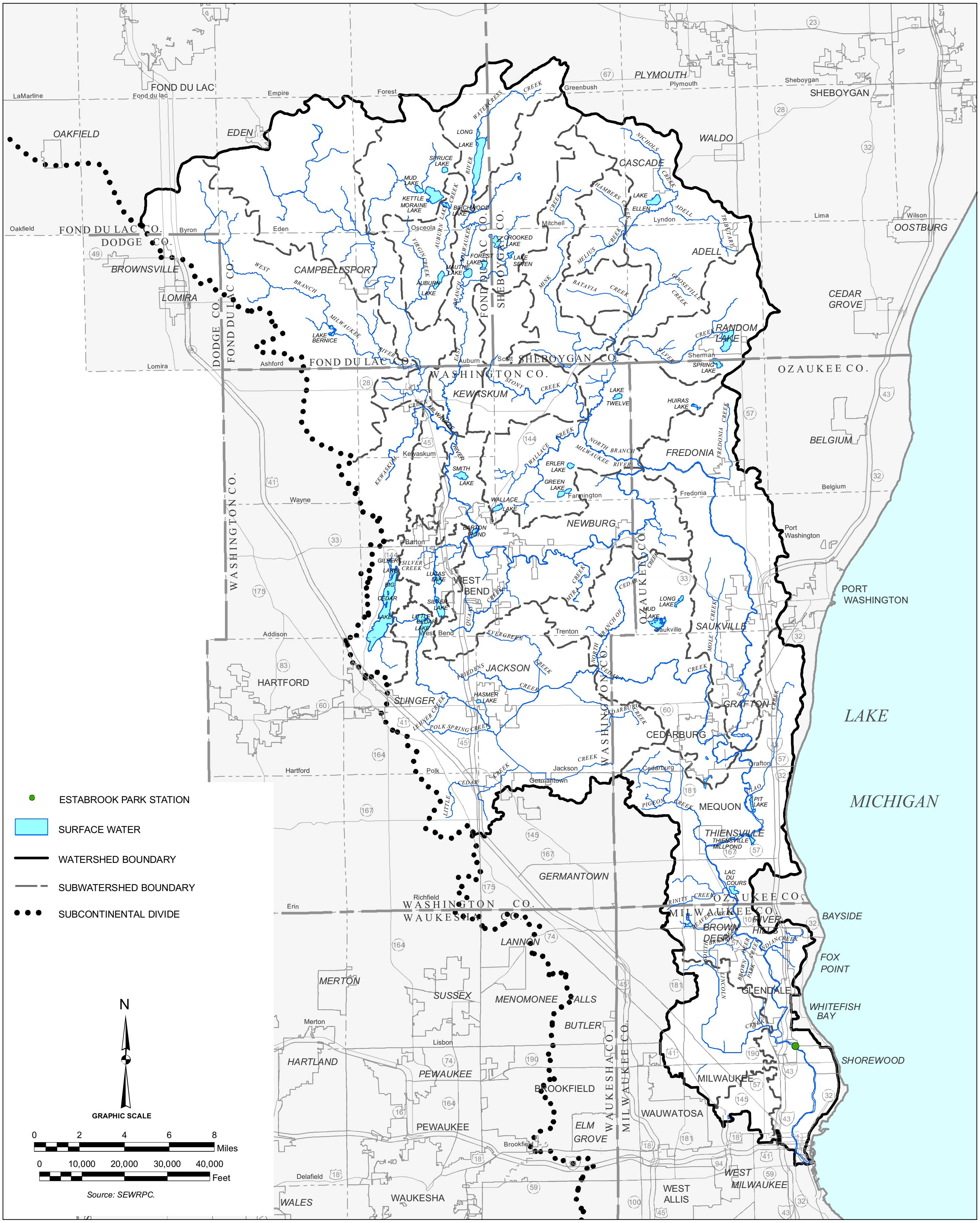
CIVIL DIVISIONS WITHIN THE MILWAUKEE RIVER WATERSHED: 2000



Source: SEWRPC.

Map 2

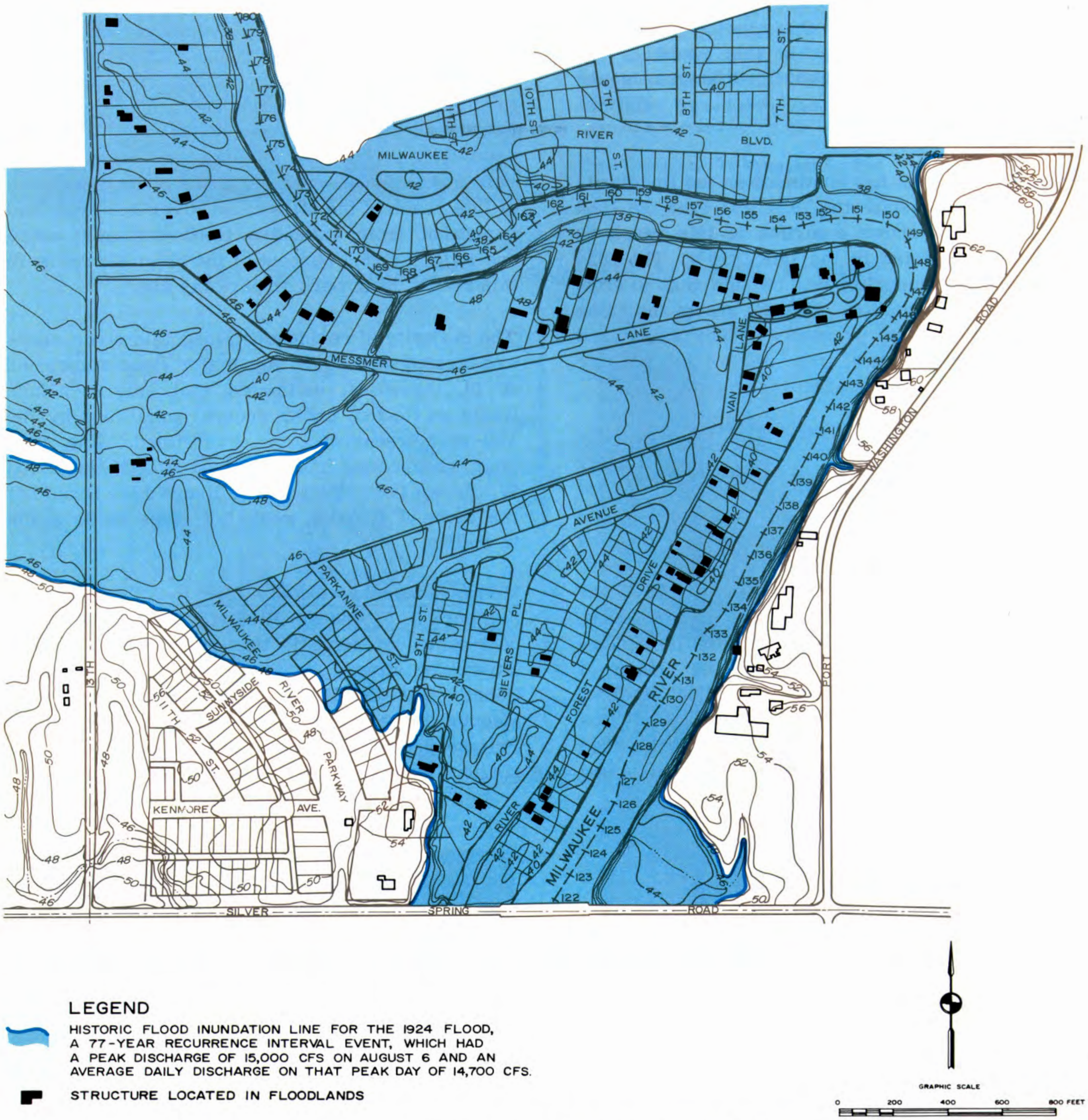
STREAMS IN THE MILWAUKEE RIVER WATERSHED: 2004



Source: SEWRPC.

Map 3

FLOOD INUNDATION MAP
PORTION OF THE CITY OF GLENDALE 1924 FLOOD



The Glendale reach of the Milwaukee River has experienced frequent and extensive flooding. A portion of this reach as it existed in 1936 is shown on the historic map reproduced above. The extent of inundation of the 1924 flood has been superimposed on the 1936 land use conditions shown on the map. This same area as it exists today is shown on Map 42. It is evident that the known flood hazard provided no deterrent to continued urban development in the floodplains of the River.

Source: Adapted from *The Milwaukee River Basin,* *Wisconsin State Planning Board Bulletin No. 10, June 1940.*

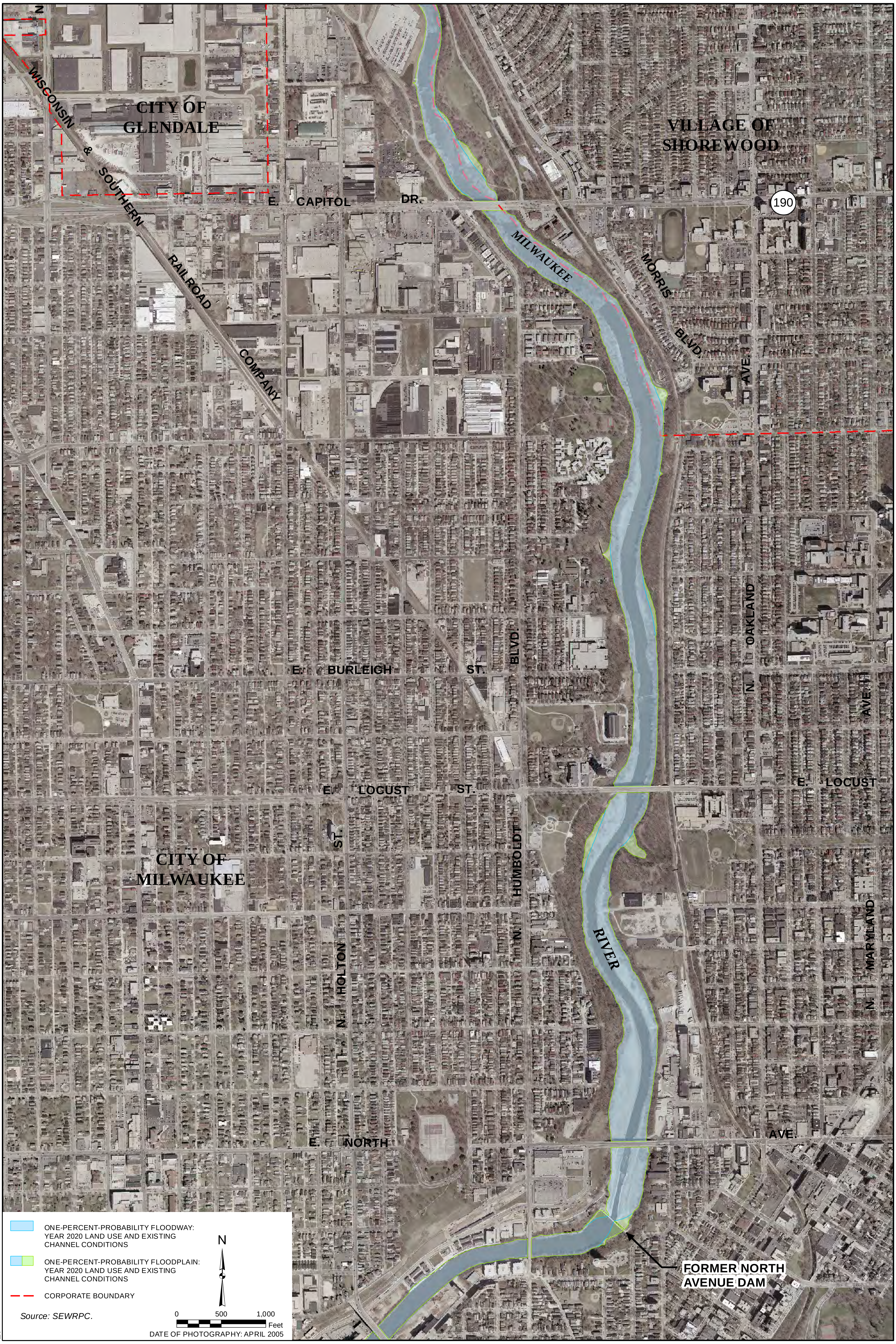
Map 4

ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODWAY AND FLOODPLAIN FOR THE MILWAUKEE RIVER: YEAR 2020 LAND USE AND EXISTING CHANNEL CONDITIONS

Map 4 (continued)

Map 4 (continued)

Map 4 (continued)



Source: SEWRPC.

Map 5

ALTERNATIVE PLAN NO. 1: ACQUISTION AND DEMOLITION OF BUILDINGS IN THE FLOODPLAIN

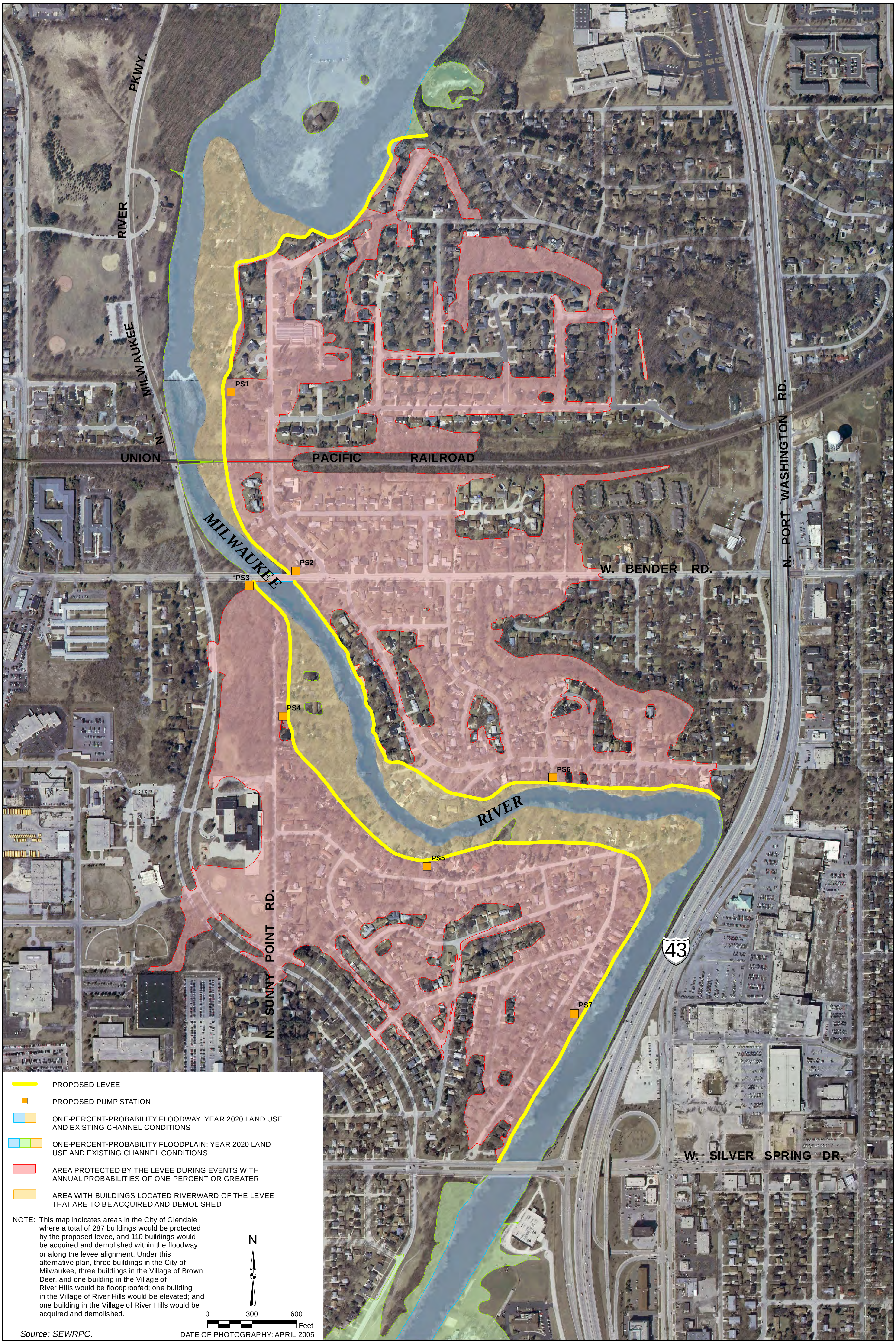
Source: SEWRPC.

Map 6

ALTERNATIVE PLAN NO. 2: FLOODPROOFING, ELEVATION, OR ACQUISTION AND DEMOLITION OF BUILDINGS IN THE FLOODPLAIN

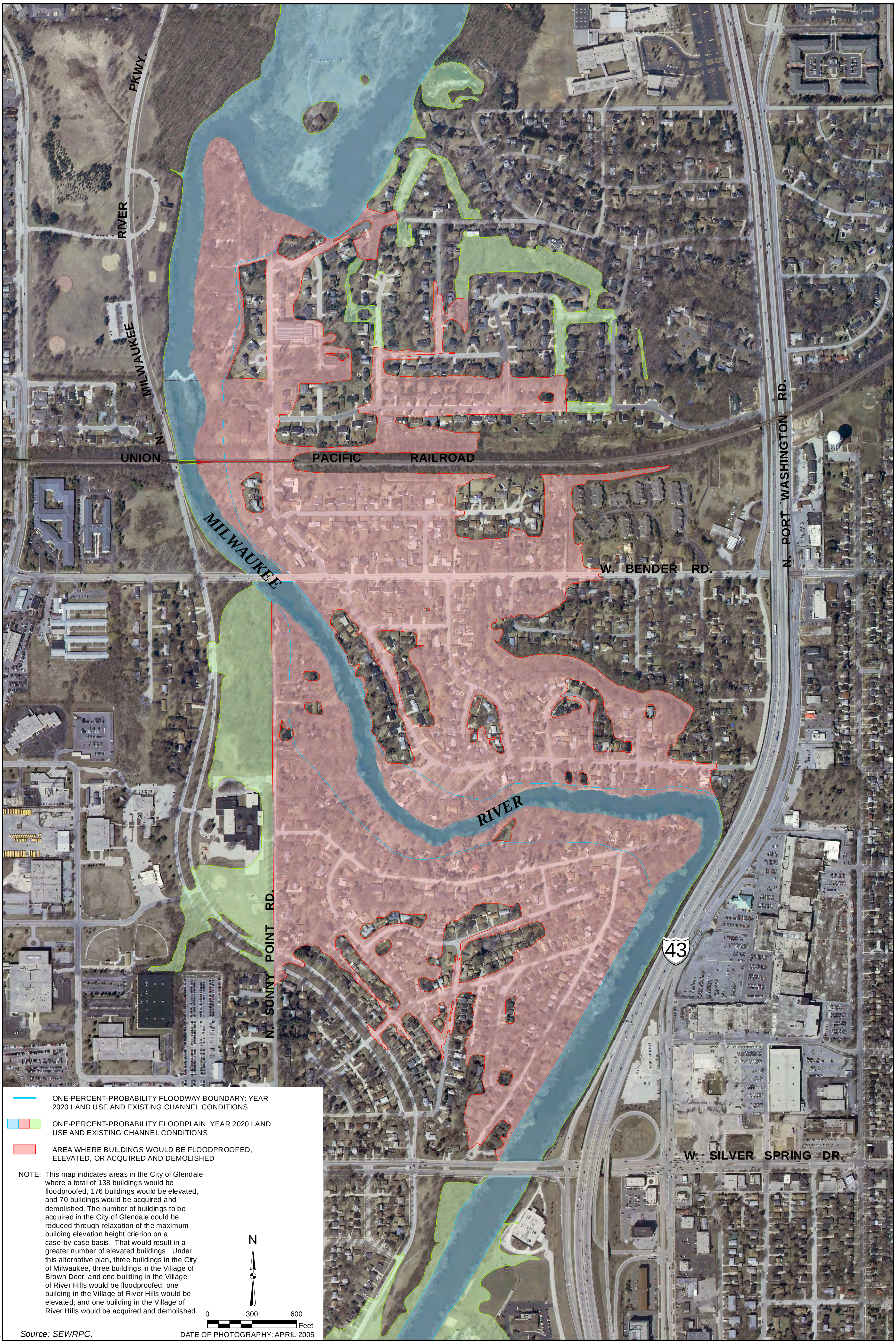
Map 7

ALTERNATIVE PLAN NO. 3: LEVEE FOR PROTECTION FROM THE ONE-PERCENT-ANNUAL-PROBABILITY FLOOD WITH FLOODPROOFING OR ACQUISTION AND DEMOLITION OF SELECTED BUILDINGS



Map 8

RECOMMENDED WATERCOURSE SYSTEM PLAN FOR THE MILWAUKEE RIVER MAIN STEM IN MILWAUKEE COUNTY: FLOODPROOFING, ELEVATION, OR ACQUISITION AND DEMOLITION OF BUILDINGS IN THE FLOODPLAIN



(This Page Left Blank Intentionally)

APPENDICES

(This Page Left Blank Intentionally)

Appendix A

HYDROLOGIC ANALYSIS

INTRODUCTION

As noted previously, the hydrologic analysis for the estimation of various probability flood flows was developed under the MMSD/MCAMLIS/SEWRPC floodland mapping program and that analysis has been incorporated in the 2006 preliminary FEMA flood insurance study for all of Milwaukee County. The study documented here establishes a consistent set of flood flows that was utilized for the computation of flood profiles and the delineation of floodplain and floodway limits along the main stem of the Milwaukee River. As described in Exhibit A, several alternative methods were applied for comparison of one-percent-probability flood flows at different points along the length of the Milwaukee River. Although the study reach extends from the Milwaukee-Ozaukee county line to the site of the former North Avenue dam, which is about 3.2 miles upstream from the mouth of the Milwaukee River at Lake Michigan, flood flows are presented for the entire 16.2-mile-long reach of the River in Milwaukee County. The hydraulic model applied to compute flood profiles was developed for that entire reach, thus the computation of flood profiles in the study reach upstream of the former North Avenue dam was based on downstream hydraulic conditions.[1]

U.S. GEOLOGICAL SURVEY (USGS) CONTINUOUS RECORDING STREAMFLOW GAGING STATION

The U.S. Geological Survey (USGS) continuous recording streamflow gaging station which has the longest period of record on the Milwaukee River is located in the City of Milwaukee in Estabrook Park at N. Richards Street extended (USGS Station No. 04087000) (see Map 2 in the main body of this report). The drainage area listed for this gaging station is 696 square miles. Daily stream flow gaging data are available for this station from the year 1915 to the present.

METHODS FOR ESTIMATING FLOOD FLOWS

The WDNR HEC-1 model developed under the 1991 Ozaukee County FIS is based on 1990 land use conditions. For the MCAMLIS/MMSD mapping program, the Regional Planning Commission staff updated the Milwaukee River watershed HEC-1 model to reflect planned year 2020 land use conditions. Natural Resource Conservation Service (NRCS) runoff curve numbers (RCN) in the HEC-1 model were updated to reflect planned 2020 conditions in those subbasins where significant changes in land use have occurred, or are anticipated, between the

---

[1]*For the 10 through 0.2-percent-annual-probability (10- through 500-year recurrence intervals) critical flow conditions occurred at the former North Avenue dam site and supercritical conditions with a hydraulic jump were computed to occur in a short reach immediately downstream from the former dam site.*

1990 condition represented in the Ozaukee County FIS model and the year 2020. These revised curve numbers are listed in Table A-1. Using these revised RCNs, reflecting 2020 land use data, and the WDNR HEC-1 model, the 100-year peak flows were computed at different points along the Milwaukee River. A comparison of the HEC-1 100-year flood values for 1990 and planned 2020 land use conditions is set forth in Table A-2. This analysis indicates that changes in land use between 1990 and 2020 along the Milwaukee River would be expected to have an insignificant effect on Milwaukee River 100-year flood flows in Milwaukee County.

The USGS streamflow gaging site on the Milwaukee River near Estabrook Park is part of the USGS Hydroclimatic Data Network. As noted in SEWRPC Technical Report No. 40, *Rainfall Frequency in the Southeastern Wisconsin Region*, April 2000, the sites in that network have a complete and accurate long-term streamflow record and reasonably unchanged basin conditions when considered within the context of the entire watershed area. Based on inclusion of the Milwaukee River gage in the USGS Hydroclimatic Data Network and on the computation of insignificant changes in flood flows under 2020 land use conditions relative to 1990 conditions as described above, it was decided to use the flood frequency relationship at the streamflow gauge to estimate 2020 flood flows at the gage and at ungaged locations in the reach extending from the gauge upstream to the Milwaukee-Ozaukee county line and downstream to the site of the former North Avenue dam.

The following three methods for determining 100-year flows in the Milwaukee River at different locations in Milwaukee County were applied and compared. The results from each of these methods are set forth in Table A-3. Method 1 is based on flood frequency analyses of the Estabrook Park gage data as performed by the USGS. Methods 2 and 3 are based on flood frequency analyses of the gage data using Water Resources Council Bulletin 17B methodology with a generalized regional skew of –0.16.[2] The development of that regional skew is described in USGS Water-Resources Investigations Report 86-4008, *Estimating Generalized Skew of the Log-Pearson Type III Distribution for Annual Flood Peaks in Illinois*, 1987.[3]

Method 1

This method is based on the flow transfer procedure for sites on Wisconsin streams near streamflow gaging sites as described in the USGS Water Resources Investigation Report 91-4128, *Flood Frequency Characteristics of Wisconsin Streams*, 1992.[4]

Method 2

This is the method applied by the WDNR for the 1991 Ozaukee County FIS. In this method, the ratio of HEC-1 generated flows at gaged and ungaged sites was computed. The exponent of the ratio of the corresponding areas is computed using the following equation and solving for “x”:

---

[2]*Bulletin 17B recommends the use of area-specific regional skews where such information is available.*

[3]*The region for which the generalized regional skew was computed includes a large portion of southern Wisconsin that encompasses the Milwaukee River watershed and the Southeastern Wisconsin Region. Data from USGS streamflow gage No. 04087000 (Milwaukee River in Estabrook Park), along with numerous other gages, was used in the analyses.*

[4]*The drainage area listed for the gage site in the annual USGS Water Resources Data for Wisconsin reports is 696 square miles. A drainage area of 682.2 square miles was determined by the WDNR for their 1991 Ozaukee County FIS analysis. That drainage area was considered to be a refinement of the USGS area and it was used for Methods 2 and 3. For the USGS flow transfer procedure (Method 1) the 696-square-mile drainage area was used. Also, under Method 1, the drainage areas for the upstream locations to which flows were transferred were determined relative to a 696-square mile area at the gage.*

$(A_{ug}/A_g)^x = (Q_{ug}/Q_g)$
A_{ug} - Drainage Area above ungaged site
A_g - Drainage Area at gaged site
Q_{ug} – HEC-1 flow at ungaged site
Q_g – HEC-1 flow at gaged site

$x = \log(Q_{ug}/Q_g)/\log(A_{ug}/A_g)$

Using the log Pearson Type III flow value at the gaged site, the flow at the ungaged site is determined using the first expression above with the value of exponent determined based on the flows computed with the WDNR HEC-1 model.

Method 3
In this method, the area exponent of 0.863, given for Area 5 in Table 1 of the 1992 USGS flood frequency characteristics report, was applied to the ratio of drainage areas at the gaged and ungaged sites and the flow at the ungaged site was computed by multiplying that result by the flow at the gaged site, as determined from a log Pearson Type III analysis of the historic record.

CONCLUSION

Methods 1 through 3 yielded similar peak 100-year flood flows. Method 3 yielded the most conservative results of the three transfer methods, and the flows based on that method are proposed to be used in the MCAMLIS/MMSD floodland mapping program as shown in Table B-1 in Appendix B.[5] In the reach from the USGS gage to the confluence with the Menomonee River, it is proposed to apply the Method 3 100-year flood flow of 14,800 cfs that was computed for the gage. In the short reach from the confluence with the Menomonee River to River Mile 0.19, at a location just upstream from the confluence with the Kinnickinnic River, a one-percent-annual- probability (100-year recurrence interval) flood flow of 26,700 cfs was used. That is the 1990 land use condition flow from SEWRPC PR No. 13 and it is the only known 100-flood flow estimate for that reach of the River. Although the 100-year floodplain elevation in the lower reaches of the Milwaukee River are governed by the 100-year flood stage of Lake Michigan, flood profiles were computed in the estuary to establish the location at which the applicable flood stage changes from the Lake elevation to channel control and also to provide a model that can be used to determine whether possible future new or replacement bridges in the estuary could create increases in 100-year flood stages upstream of the estuary. The instantaneous 100-year recurrence interval flood stage elevation of Lake Michigan along the pertinent portion of the Lake coast was established as 584.3 feet above National Geodetic Vertical Datum, 1929 adjustment, in U.S. Army Corps of Engineers *Revised Report on Great Lakes Open-Coast Flood Levels (Phase 1)*, April 1988. Under the MCAMLIS/MMSD floodland mapping program, it is proposed to use that stage to map the floodplain throughout the Milwaukee Harbor Estuary, which includes the downstream reaches of the Milwaukee, Kinnickinnic, and Menomonee Rivers.

---

[5]*For consistency with the December 4, 2007, Ozaukee County FIS, which listed a 100-year flood flow of 14,210 cfs at the Milwaukee-Ozaukee county line, the Method 3 flow of 14,340 that was computed at Green Tree Road (River Mile 11.29) was used from that location upstream to the county line.*

(This Page Left Blank Intentionally)

Appendix A

HYDROLOGIC ANALYSIS

TABLES

(This Page Left Blank Intentionally)

Table A-1

RUNOFF CURVE NUMBERS FOR MILWAUKEE RIVER SUBBASINS EXPECTED TO BE IMPACTED BY LAND USE CHANGES FROM 1980 THROUGH 2020

Subbasin	Area (square miles)	Runoff Curve Number	
		2020	1980
LCC-15	- -	80.6	80.0
LCC-16	- -	78.0	75.0
LCC-17	2.601	77.7	75.0
LMR-10	1.669	81.7	70.4
LMR-11	0.838	79.2	76.9
LMR-12	1.327	81.7	72.8
LMR-18	1.779	82.6	81.6
LMR-19	1.758	82.6	80.9
LMR-2	0.904	81.4	71.0
LMR-20	1.727	81.1	69.7
LMR-21	1.651	78.0	74.2
LMR-22	1.108	79.6	78.8
LMR-23	1.047	78.8	78.7
LMR-24	2.543	78.4	77.2
MMR-14	- -	72.7	69.7
MMR-15	- -	70.3	69.7
ULMR-11	- -	74.5	69.4
ULMR-12	2.741[a]	74.8	69.4
ULMR-23	1.478	76.7	71.7
ULMR-9	1.982	77.6	75.0
UMR-36	1.050	72.5	70.7
UMR-37	0.708	77.6	69.6

[a]*Total for ULMR-11 and ULMR-12.*

Source: Wisconsin Department of Natural Resources and SEWRPC.

Table A-2

COMPARISON OF RESULTS OF DIFFERENT METHODS FOR COMPUTING 100-YEAR FLOOD FLOWS ALONG THE MILWAUKEE RIVER IN MILWAUKEE COUNTY

Subbasin Designation in WDNR HEC-1 Model	Area (square mile)[a]	Q100 (cfs)				
		WDNR 1991 Ozaukee County FIS HEC-1 Model: 1990 Land Use, Existing Channel	WDNR 1991 Ozaukee County FIS HEC-1 Model: 2020 Land Use, Existing Channel	USGS Transfer (Method 1)	HEC-1 Exponent to Transfer LP III Flow from Gage Site (Method 2)	Area Ratio Transfer with Exponent from USGS Regional Flood Frequency Equation (Method 3)
CB142	639.54	12,965	13,037	13,705	12,034	14,021[b]
CB143	644.15	12,930	13,027	13,795	12,314	14,105[b]
CB144	648.44	12,871	13,003	13,911	12,579	14,184[b]
CB145	651.20	12,871	12,943	13,986	12,751	14,234[b]
CB146	654.83	12,867	12,940	14,083	12,980	14,301[b]
CB147	655.84	12,865	12,938	14,110	13,045	14,319[b]
CB148	657.72	12,861	12,933	14,161	13,165	14,354
CB149	659.03	12,845	12,918	14,196	13,249	14,378
CB150	660.00	12,843	12,916	14,221	13,312	14,396
CB158	680.20	14,964	14,967	14,749	14,662	14,764
CB159[c]	682.19	16,033	16,034	14,800	14,800	14,800

[a] *Area from WDNR HEC-1 model.*

[b] *A flow of 14,350 cfs is to be applied at these locations for consistency with the 1991 and 2007 Ozaukee County FIS reports.*

[c] *USGS streamflow gage at Estabrook Park.*

Source: SEWRPC.

Appendix B

MILWAUKEE RIVER FLOOD FLOW AND STAGE INFORMATION

(This Page Left Blank Intentionally)

Table B-1

ESTIMATED MILWAUKEE RIVER FLOOD FLOWS AT VARIOUS LOCATIONS IN MILWAUKEE COUNTY

Location	River Mile	Annual Probability of Occurrence (recurrence interval)			
		10 Percent (10-year)	2 Percent (50-year)	1 Percent (100-year)	0.2 Percent (500-year)
Just Upstream of Confluence with the Kinnickinnic River	0.19	13,100	19,400	26,700	34,220
Downstream of S. Water Street Bridge	0.77	13,100	19,400	26,700	34,220
E. Buffalo Street	0.99	8,790	12,900	14,800	18,810
Former North Avenue Dam	3.12	8,790	12,900	14,800	18,810
USGS Gaging Station No. 04087000	6.5	8,790	12,900	14,800	18,810
Downstream of Estabrook Park Dam	6.67	8,790	12,900	14,800	18,810
Near N. Port Washington Road Bridge	6.89	8,790	12,860	14,800	18,810
North End of Lincoln Park	7.98	8,790	12,550	14,380	18,240
Wisconsin & Southern Railroad	8.09	8,790	12,550	14,380	18,240
W. Silver Spring Drive	8.5	8,790	12,550	14,340	18,240
W. Green Tree Road	11.29	8,790	12,550	14,340	18,240
Milwaukee/Ozaukee County Line	16.34	8,790	12,550	14,340	18,240

Source: Federal Emergency Management Agency and SEWRPC.

Table B-2

MILWAUKEE RIVER FLOOD STAGES: EXISTING CHANNEL WITH PLANNED YEAR 2020 LAND USE CONDITIONS[a]

Location (River Mile)	Description	Flood Stage Elevation (feet above NGVD 1929)			
		10-Percent Annual-Probability (10-year)	2-Percent Annual-Probability (50-year)	1-Percent Annual-Probability (100-year)	0.2-Percent Annual-Probability (500-year)
3.21	Former North Avenue Dam	582.15	583.80	584.28	585.26
3.22		588.95	591.22	592.22	593.80
3.252		591.82	594.64	595.38	597.81
3.292		591.99	594.71	595.92	598.18
3.348		591.71	594.88	596.16	598.45
3.36		593.53	596.07	597.09	599.15
3.366		593.44	596.00	597.02	599.08
3.37	E. North Avenue				
3.38		593.75	596.15	597.14	599.18
3.391		593.59	595.85	596.80	598.88
3.496		594.35	596.65	597.63	599.50
3.647		594.72	597.06	598.05	599.87
3.765		595.09	597.48	598.48	600.31
3.938		595.68	597.99	598.95	600.72
4.109		596.03	598.41	599.39	601.22
4.175		596.18	598.53	599.52	601.34
4.18	E. Locust Street				
4.194		596.56	598.98	599.96	601.79
4.296		597.28	599.45	600.35	602.06
4.45		597.70	599.91	600.83	602.60
4.542		597.96	600.21	601.15	602.95
4.791		598.65	600.94	601.88	603.70
5.022		599.27	601.56	602.49	604.29
5.326		600.33	602.59	603.51	605.28
5.558		601.66	603.82	604.72	606.46
5.59	E. Capitol Drive				
5.593		601.94	604.09	604.99	606.74
5.642		602.13	604.23	605.12	606.87
5.863		605.34	607.07	607.78	609.13
6.173		609.05	610.95	611.72	613.20
6.403		611.90	613.75	614.52	616.00
6.405	Wisconsin & Southern Railroad Company				
6.408		612.27	614.31	615.16	616.82
6.422		612.18	614.07	614.87	616.43
6.567		614.33	616.65	617.63	619.60
6.61		615.19	617.48	618.45	620.39
6.756		615.92	618.10	619.05	620.95
6.811		616.03	618.20	619.14	621.04
6.827		616.12	618.29	619.23	621.11
6.8275	Estabrook Park Dam				
6.829		617.70	619.61	620.46	622.09
6.843		617.71	619.61	620.47	622.09

Table B-2 (continued)

Location (River Mile)	Description	Flood Stage Elevation (feet above NGVD 1929) 10-Percent Annual-Probability (10-year)	2-Percent Annual-Probability (50-year)	1-Percent Annual-Probability (100-year)	0.2-Percent Annual-Probability (500-year)
7.087		617.84	619.72	620.56	622.16
7.103		617.85	619.73	620.57	622.16
7.11	N. Port Washington Road				
7.117		617.91	619.79	620.63	622.23
7.16		617.99	619.88	620.72	622.32
7.17	IH 43				
7.183		618.26	620.16	620.99	622.58
7.189		618.42	620.33	621.17	622.76
7.19	IH 43 Ramp				
7.199		619.06	620.98	621.82	623.43
7.633		619.79	621.77	622.63	624.26
7.654		619.83	621.83	622.69	624.33
7.66	W. Hampton Avenue				
7.669		619.88	621.89	622.75	624.41
7.876		620.04	622.16	623.07	624.82
7.934		620.07	622.18	623.08	624.83
8.003		620.09	622.19	623.10	624.84
8.132		620.14	622.23	623.14	624.88
8.141		620.13	622.23	623.14	624.87
8.145		620.14	622.23	623.14	624.88
8.229		620.11	622.14	623.02	624.70
8.341		620.23	622.25	623.12	624.79
8.357		619.85	621.80	622.65	624.25
8.36	Wisconsin & Southern Railroad Company				
8.375		620.89	623.02	623.91	625.64
8.381		620.95	623.08	623.96	625.68
8.394		621.62	623.87	624.81	626.66
8.579		622.27	624.58	625.55	627.45
8.66		622.54	624.88	625.87	627.81
8.716		622.68	625.02	626.00	627.94
8.73		622.67	625.01	625.99	627.93
8.74	W. Silver Spring Road				
8.759		622.81	625.14	626.13	628.10
8.783		622.87	625.19	626.18	628.15
8.963		623.33	625.65	626.64	628.59
9.125		623.82	626.13	627.10	629.05
9.427		625.06	627.37	628.36	630.34
9.669		625.83	628.10	629.08	631.03
9.846		627.21	629.18	629.99	631.72
10.009		628.25	630.40	631.23	632.84
10.023		628.35	630.53	631.37	633.02
10.04	W. Bender Road				
10.051		628.31	630.48	631.32	633.39
10.192		629.14	631.47	632.40	634.58

Table B-2 (continued)

Location (River Mile)	Description	Flood Stage Elevation (feet above NGVD 1929)			
		10-Percent Annual-Probability (10-year)	2-Percent Annual-Probability (50-year)	1-Percent Annual-Probability (100-year)	0.2-Percent Annual-Probability (500-year)
10.212		629.19	631.55	632.50	634.69
10.22	Union Pacific Railroad				
10.226		629.45	631.82	632.78	635.00
10.231		629.46	631.83	632.80	635.01
10.26		629.57	631.94	632.91	635.12
10.326		629.79	632.18	633.15	635.37
10.34	Inline Structure				
10.351		630.48	632.30	633.22	635.40
10.489		630.75	632.58	633.49	635.62
10.937		631.51	633.38	634.28	636.36
11.228		631.82	633.63	634.50	636.53
11.488		633.26	634.66	635.29	636.85
11.524		633.51	634.88	635.49	636.99
11.53	W. Green Tree Road				
11.537		634.16	635.70	636.38	637.95
11.55		634.26	635.81	636.50	638.08
11.573		634.38	635.93	636.61	638.18
11.795		635.80	637.70	638.53	640.28
11.919		636.30	638.19	639.01	640.77
11.923		636.47	638.38	639.21	640.96
11.94	W. Good Hope Road				
11.955		636.85	638.75	639.61	641.46
11.96		636.81	638.70	639.56	641.42
12.131		637.52	639.34	640.16	641.95
12.481		639.33	641.12	641.90	643.55
12.89		642.23	644.02	644.79	646.36
13.068		643.84	645.45	646.18	647.70
13.069		643.81	645.38	646.10	647.62
13.07	Golf Course Pedestrian Bridge				
13.079		644.47	646.40	647.14	648.32
13.089		644.54	646.47	647.21	648.38
13.394		645.63	647.34	648.04	649.24
13.399		645.64	647.35	648.06	649.26
13.4	Golf Course Pedestrian Bridge				
13.414		645.70	647.44	648.15	649.39
13.766		646.40	648.10	648.78	650.02
14.035		646.72	648.48	649.18	650.46
14.062		646.73	648.49	649.20	650.48
14.07	N. Range Line Road				
14.083		646.91	648.72	649.46	650.83
14.091		646.97	648.81	649.55	650.96
14.379		647.26	649.15	649.92	651.38
14.874		647.53	649.46	650.25	651.76
15.27		647.79	649.76	650.57	652.11

Table B-2 (continued)

Location (River Mile)	Description	Flood Stage Elevation (feet above NGVD 1929)			
		10-Percent Annual-Probability (10-year)	2-Percent Annual-Probability (50-year)	1-Percent Annual-Probability (100-year)	0.2-Percent Annual-Probability (500-year)
15.279		647.76	649.68	650.47	651.96
15.3	W. Brown Deer Road				
15.307		647.90	649.85	650.65	652.16
15.337		647.94	649.89	650.69	652.21
15.362		648.05	650.11	650.98	652.65
15.373		648.16	650.22	651.08	652.74
15.393		648.25	650.31	651.17	652.83
15.425		648.31	650.37	651.23	652.89
15.491		648.34	650.38	651.23	652.88
15.525		648.34	650.37	651.22	652.86
15.551		648.42	650.46	651.31	652.94
15.714		648.67	650.71	651.56	653.21
15.941		648.95	650.96	651.79	653.41
16.074		649.28	651.33	652.17	653.80
16.229		649.72	651.70	652.51	654.10
16.412		650.32	652.27	653.06	654.62
16.617		650.60	652.58	653.40	654.99

[a]*These flood stage elevations are also generally applicable to each of the three alternative plans analyzed, although some flood stage reductions might be achieved under Alternative Nos. 1 and 2, with all or some floodplain buildings removed, resulting in a wider floodway.*

Source: SEWRPC.

(This Page Left Blank Intentionally)

Appendix C

CITY OF GLENDALE COMMENTS ON JANUARY 2009 PRELIMINARY DRAFT OF THE MILWAUKEE RIVER WATERCOURSE SYSTEM PLAN

(This Page Left Blank Intentionally)

CITY OF GLENDALE
ADMINISTRATIVE OFFICES

Glendale
RICH PAST. BRIGHT FUTURE.

5909 North Milwaukee River Parkway
Glendale, Wisconsin 53209-3815
(414)228-1705

October 14, 2009

Mr. Mike Hahn
Southeastern Wisconsin Regional Planning Commission
P.O. Box 1607
Waukesha, WI 53187-1607

Mr. Mike Martin
Milwaukee Metropolitan Sewerage District
260 West Seeboth Street
Milwaukee, WI 53204

Re: Draft Report/Water Course System Plan for the Milwaukee River

Gentlemen:

On behalf of the City of Glendale, we wish to thank you for the opportunity to meet with you to discuss the preliminary draft report on the Water Course Plan for the Milwaukee River in Milwaukee County.

As discussed, the City of Glendale has serious concerns regarding the alternative referenced, requiring the acquisition of 384 homes in Glendale. If this were to occur, it would represent the elimination of 8% of the City's existing single family housing and 7.6% of the City's housing value, based upon January 1, 2009 Wisconsin Department of Revenue data. Utilizing that same database, the annual tax loss for Glendale would be in excess of $2,038,000, or approximately 5% of the City's total tax levy. The specific impact on the City's utilities (water, sanitary and storm) has not been calculated, nor has the potential fiscal impact on the City's K-8 school district (Glendale-River Hills) or Nicolet High School.

Regarding the 1997 referenced flood, you will find enclosed the flood report as submitted to the Federal Emergency Management Agency in October of that year. The report indicates there were no major residential damages and 128 minor residential damages.

Also, as discussed at our meeting, the City of Glendale would be willing to work with the Regional Planning Commission and MMSD to develop a fully funded voluntary residential acquisition program for the area referred to as the Sunny Point Peninsula in the draft report. It is these homes located within this area that have regular ongoing flood related issues and costs.

In addition, the City would be willing to work with the Regional Planning Commission and MMSD to develop and implement a fully funded residential flood-proofing program for structures located within the designated 100 year flood plain area. We believe that a fully funded program, together with a properly designed educational program for residential property owners could, in a period of time, result in the desired efforts mentioned as Alternative #2 in the report.

Please keep us advised as to the next step or process that your preliminary draft report will receive from either the Regional Planning Commission or MMSD. If the plan proceeds, it is absolutely critical that a series of public informational meetings be held in Glendale, so that all affected property owners can express their opinions and reactions to the report.

Thank you for your attention and assistance.

Sincerely,

CITY OF GLENDALE

Richard E. Maslowski

Richard E. Maslowski
City Administrator

mw

Enclosure

cc: Jerome Tepper, Mayor
John Fuchs, City Attorney
Collin Johnson, Director of Inspection Services

Glendale
RICH PAST.
BRIGHT FUTURE.

CITY OF GLENDALE
ADMINISTRATIVE OFFICES

5909 North Milwaukee River Parkway
Glendale, Wisconsin 53209-3815
(414) 228-1705

October 7, 1997

Mr. Stuart A. Rifkind, Director
Mitigation Division
Federal Emergency Management Agency
175 West Jackson Boulevard, 4th Floor
Chicago, IL 60604-2698

Dear Mr. Rifkind:

In response to your letter dated October 1, 1997 addressed to Mayor Voith, please be advised there were no substantially damaged structures in the City of Glendale due to the flooding that occurred in June.

Sincerely,

CITY OF GLENDALE

Richard E. Maslowski

Richard E. Maslowski
City Administrator

mw

2400 Wright Street
P.O. BOX 7865
MADISON, WI 53707-7865

TELEPHONE (608) 242-3232
(800) 943-0003
FAX (608) 242-3248

DEG USE ONLY

DATE & TIME REPORT RECEIVED

RECEIVED BY

DEPARTMENT OF MILITARY AFFAIRS
WISCONSIN DIVISION OF EMERGENCY GOVERNMENT
UNIFORM DISASTER SITUATION REPORT

1 NAME OF PERSON SUBMITTING REPORT: Richard E. Maslowski	ADDRESS, CITY, STATE, ZIP: 5909 N. Milwaukee River Pkwy Glendale, WI 53209	PHONE NO.: 228-7714
2 DATE & TIME OF INCIDENT: 1AM on 6/21/97 to 8AM 6/23/97	3 TYPE OF INCIDENT/EMERGENCY: Flash Flood	4 DATE REPORT SUBMITTED TO DEG: 10-7-97

5 LOCATION OF INCIDENT:	DEG AREA	COUNTY: Milwaukee
CITY: Glendale	VILLAGE: —	TOWNSHIP: —
SECTION: — entire city —	OTHER LOCATION DETAILS (ATTACH A MAP SHOWING LOCATIONS)	

6 ESTIMATED NO. OF CASUALTIES:	DEATHS	INJURIES	HOMELESS	EVACUATED
	0	2	0	37

7 PRIVATE SECTOR DAMAGE ESTIMATES: Final Report

	MINOR	MAJOR	DESTROYED	ESTIMATED DOLLAR AMOUNT	ESTIMATED PERCENT COVERED BY INSURANCE
RESIDENTIAL (ESTIMATED NO. OF HOMES)	128	0	0	$ 150,000	70 %
BUSINESS (ESTIMATED NO. OF BUSINESSES)				$	%
PRIVATE UTILITY/INDUSTRY (ESTIMATED NO. OF PRIVATE UTILITIES/INDUSTRIES)				$	%
AGRICULTURAL (ESTIMATED NO. OF FARM BUILDINGS)				$	%

AGRICULTURAL (Continued)	LIVESTOCK LOST NO.	LIVESTOCK LOST ESTIMATED DOLLAR AMOUNT	CROPS AFFECTED NO. OF ACRES	CROPS AFFECTED ESTIMATED DOLLAR AMOUNT
		$		$

8 TOTAL ESTIMATED PRIVATE SECTOR DAMAGE
$ 150,000

9 PUBLIC SECTOR DAMAGE ESTIMATES:

A) DEBRIS CLEARANCE: $125,000	B) PROTECTIVE MEASURES: $35,000	C) ROAD SYSTEMS: $90,000	D) WATER CONTROL FACILITIES: 0
E) PUBLIC BUILDINGS & RELATED EQUIPMENT: 5,000	F) PUBLIC UTILITY SYSTEMS: 0	G) OTHER (NOT IN PRECEDING CATEGORIES): 0	

10 TOTAL ESTIMATED PUBLIC SECTOR DAMAGE
$ 255,000

11 DESCRIBE LOCAL ACTIONS TAKEN OR TO BE TAKEN. INCLUDE NAMES OF AGENCIES AND PUBLIC OFFICIALS INVOLVED IN THE RESPONSE EFFORTS.

City Police, Fire, Public Works and Red Cross responded to provide emergency shelter, rescue, traffic control, and street/utility repairs. Flood Debris cleanup and removal currently in operation.

12 DESCRIBE OUTSIDE ASSISTANCE NEEDED OR BEING REQUESTED.

Private haulers ~~of~~ for flood debris removal and private contractors for street repairs will be used.

13 ADDITIONAL COMMENTS (INCLUDING ECONOMIC OR OTHER IMPACTS ON AFFECTED COMMUNITIES:

Federal Emergency Management Agency
Region V
175 West Jackson Blvd., 4th Floor
Chicago, IL 60604-2698

OCT 0 1 1997

Honorable Donald Voith, Mayor
City of Glendale
5909 North Milwaukee Parkway
Glendale, WI 53209

Dear Mayor Voith:

We understand your community recently experienced flood damage. Your community participates in the National Flood Insurance Program (NFIP), which makes federally-backed flood insurance available to homeowners and businesses throughout your community, in return for adoption and enforcement of floodplain management regulations.

Your community has adopted floodplain management regulations, requiring permits for all types of development in the Special Flood Hazards Areas (SFHAs), as identified on your Flood Hazard Boundary Map (FHBM) or Flood Insurance Rate Map (FIRM). You must enforce the requirements in your floodplain management ordinance which requires new construction to be protected to at least the flood protection elevation. Substantial improvements or substantial repairs to existing buildings must also meet the requirements of your ordinance. Other federal and state permits may be required as well.

The NFIP defines "substantial damage" as damage (by any means) sustained by a structure whereby the cost of restoring the structure to its before damage condition would equal or exceed 50% of the market value of the structure before the damage occurred. This includes public structures as well.

Please be certain substantially damaged buildings are brought into compliance with your floodplain management ordinance, so that your community will be less flood-prone and your flood insurance availability is maintained. Please advise us within 30 days of the date of this letter how many substantially damaged structures you have reported for your community and how you plan to bring them into compliance with your floodplain ordinance.

If you have any question regarding flood insurance or floodplain management regulation, please call Nancy Olson at (312) 408-5576.

Sincerely,

David L Schein

for Stuart A. Rifkind, Director
Mitigation Division

cc: Bob Watson, Wisconsin Department of Natural Resources

(This Page Left Blank Intentionally)

Appendix D

AUGUST 5, 2010 SEWRPC LETTER TO THE CITY OF GLENDALE AND AUGUST 17, 2010 CITY REPLY

(This Page Left Blank Intentionally)

COPY

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

W239 N1812 ROCKWOOD DRIVE • PO BOX 1607 • WAUKESHA, WI 53187-1607• **TELEPHONE (262) 547-6721**
FAX (262) 547-1103

Serving the Counties of: KENOSHA, MILWAUKEE, OZAUKEE, RACINE, WALWORTH, WASHINGTON, WAUKESHA

August 5, 2010

Mr. Richard E. Maslowski
Administrator
City of Glendale
5909 North Milwaukee River Parkway
Glendale, WI 53209-3815

Dear Mr. Maslowski:

Pursuant to your request at the July 29, 2010 intergovernmental meeting of the City, MMSD, and SEWRPC staffs, we are providing a summary of the flood mitigation recommendations pertinent to the City as set forth in preliminary draft SEWRPC Memorandum Report No. 172 (MR No. 172), *A Watercourse System Plan for the Milwaukee River in Milwaukee County Upstream of the Milwaukee Harbor Estuary*, January 2009, revised May 2010. It is our understanding that the City will use the summary to develop a preferred approach for implementing the plan recommendations, and that the City will convey that preferred approach to MMSD and SEWRPC in writing.

The preliminary recommended plan is Alternative Plan No. 2—Floodproofing, Elevation, or Acquisition and Demolition of Buildings in the One-Percent-Annual-Probability Floodplain (see page 11 of the preliminary draft of MR No. 172). The plan components in each affected municipality (the Cities of Glendale and Milwaukee and the Villages of Brown Deer and River Hills) and estimated capital and operation and maintenance costs are set forth in the attached Table 7, which is taken from MR No. 172. Under this alternative plan, in the City of Glendale, 138 buildings would be floodproofed, 176 buildings would be elevated, and 70 buildings would be purchased and demolished and removed from the floodplain. The open space that would be created in areas where buildings were removed would remain in public ownership and would be prohibited from future development with inhabited structures. The approximate extents of the areas in which buildings would be floodproofed, elevated, or purchased under this alternative are shown on the enclosed Map 6, which is taken from MR No. 172.

It was assumed that floodproofing of residential structures would be feasible if the one-percent-probability flood stage was below the estimated first floor elevation. Structure elevation was considered feasible for residential structures with basements if the estimated cost of elevating the structure was less than the estimated cost of removing the structure. It was also assumed that structures would be elevated two feet above the one-percent-probability flood stage, and that the maximum structure elevation height would be four feet above grade. If a structure would have to be elevated more than four feet to achieve the desired two feet of freeboard above the design flood stage, it was assumed that the structure would be purchased and demolished. As noted by the SEWRPC staff during the July 2010 meeting, it might be possible to revise the building elevation criterion to allow buildings to be elevated more than a total of four feet. Such an approach would have to be evaluated on a case-by-case basis.

Preliminary draft MR No. 172 includes SEWRPC staff responses to the City's October 14, 2009 letter commenting on an earlier version of the draft report. In those responses, we noted that a fully MMSD-funded, voluntary residential acquisition program for the area referred to as the Sunny Point Peninsula and a cooperative program involving the City, MMSD, and SEWRPC to develop and implement a fully-funded residential floodproofing program for structures located within the designated one-percent-annual-probability (100-year recurrence interval) floodplain represents an appropriate local refinement for phased implementation of Alternative No. 2. The draft report also noted that the MMSD policy regarding floodproofing of private buildings allows MMSD to pay the cost of floodproofing when it is less than acquisition and demolition if the property owner places a restriction on the deed of the property which allows MMSD to periodically inspect the floodproofing measures to be sure they are functioning as intended. MMSD considers building elevation to be a form of floodproofing, thus, this policy would also apply to building elevation. MMSD also has traditionally paid for building acquisition, demolition, and removal when recommended under an adopted watercourse system plan. Thus, the City's desire for a fully-funded program could be met if the deed restrictions can be obtained for floodproofing and elevation of private buildings.

Thank you for your efforts in coordinating this process to develop a workable approach to providing flood protection to the residents of the City. Please indicate to MMSD and us the City's preferred approach to implementing flood mitigation measures within the context of the preliminary recommended plan. Feel free to contact Mr. Hahn directly with questions. We would appreciate receiving your response by September 1, 2010, enabling the report to be finalized in time for it to be presented to the MMSD Commission at its November 2010 meeting.

Sincerely,

Kenneth R. Yunker, P.E.
Executive Director

KRY/MGH/pk
#152830 V1 - MR WCSP PRELIM RECOMM SUMMARY LETTER

Enclosures

cc: Mr. Kevin L. Shafer, MMSD (w/enclosures)
Mr. Michael J. Martin, MMSD (w/enclosures)
Mr. Thomas W. Chapman, MMSD (w/enclosures)

Table 7

MILWAUKEE RIVER MAINSTEM IN MILWAUKEE COUNTY – COST ANALYSIS
ALTERNATIVE NO. 2 – FLOODPROOFING, ELEVATION, OR ACQUISITION AND DEMOLITION OF BUILDINGS IN THE ONE-PERCENT-ANNUAL-PROBABILITY (100-YEAR RECURRENCE INTERVAL) FLOODPLAIN

Municipality	Number of Buildings to Be Floodproofed	Floodproofing Cost[a]	Number of Buildings to Be Elevated	Elevation Cost[b]	Number of Buildings to Be Acquired and Demolished	Acquisition Cost[c]	Total Capital Cost for Structure Floodproofing, Elevation, or Acquisition and Demolition	Average Annual Cost[d]	Average Annual Benefits	Benefit-Cost Ratio
City of Glendale	138	$2,400,000	176	$15,800,000	70	$19,500,000	$37,700,000	$2,400,000	$450,000 [e]	0.19
City of Milwaukee..........	3	50,000	- -	- -	- -	- -	50,000	3,000	200	0.07
Village of Brown Deer	3	50,000	- -	- -	- -	- -	50,000	3,000	300	0.10
Village of River Hills.......	1	20,000	1	90,000	1	300,000	410,000	30,000	9,000	0.30
TOTAL	**145**	**$2,520,000**	**177**	**$15,890,000**	**71**	**$19,800,000**	**$38,210,000**	**$2,436,000**	**$459,500**	**0.19**

[a] *Single-family house: $17,000. Industrial. commercial building: Fair market value x (0.07 + 0.05 x height, in feet, of floodproofing above first floor).*

[b] *$90,000 per single-family house.*

[c] *Based on year 2006 or 2007 fair market value of improvements and land plus $45,000 per residential structure, and $80,000 per commercial structure, for demolition, relocation assistance, moving expenses, title insurance, closing costs, appraisal, surveys, property taxes, and miscellaneous fees.*

[d] *Amortized capital cost is based on an interest rate of 6 percent and a project life of 50 years.*

[e] *Equal to the average annual flood damages avoided during a one-percent-annual-probability flood through removal of 70 buildings in the one-percent floodplain plus an estimate of the proportion of the incremental damages between a one-percent-probability event and the total damages (with total damages including floods with probabilities of less than one percent) that would be avoided through demolition of those 70 buildings.*

Source: SEWRPC.

Map 6

ALTERNATIVE PLAN NO. 2: FLOODPROOFING, ELEVATION, OR ACQUISTION AND DEMOLITION OF BUILDINGS IN THE FLOODPLAIN

PRELIMINARY DRAFT

CITY OF GLENDALE
ADMINISTRATIVE OFFICES
5909 North Milwaukee River Parkway
Glendale, Wisconsin 53209-3815
(414)228-1705

August 17, 2010

Mr. Kenneth R. Yunker, P.E., Executive Director
Southeastern Wisconsin Regional Planning Commission
W239 N1812 Rockwood Drive
P. O. Box 1607
Waukesha, WI 53187-1607

Re: Draft SEWRPC Memorandum #172 - Milwaukee River

Dear Mr. Yunker:

The City of Glendale has continued its review of the draft SEWRPC report regarding a Watercourse System Plan for the Milwaukee River in Milwaukee County. In addition, we have reviewed and discussed your letter of August 5, 2010 relative to the summary of intergovernmental meetings of the City, MMSD and SEWPRC staff.

The City of Glendale continues to support a fully funded MMSD voluntary residential acquisition program for the nineteen properties referred to as the Sunny Point Peninsula within the City of Glendale. In addition, Glendale supports, and will cooperate, with MMSD and SEWRPC to develop and implement a fully funded residential floodproofing program for structures located within the designated one-percent-annual-probability floodplain.

As more specific information becomes known, Glendale requests that it be fully informed as to the individual properties designated for floodproofing and elevation. We do remain very concerned as to the possible number of properties that might be identified for potential acquisition outside the Sunny Point Peninsula area.

We understand that the floodproofing program could also involve structure elevation for those residential structures with basements, if their estimated cost of elevating the structure would be less than the estimated cost of removing the structure. We also understand that a fully funded MMSD program for floodproofing, elevation changes and possible acquisition would require a restriction on the deed of the property regarding future inspections, and future uses of land if acquired.

The critical component for Glendale's support and cooperation of this program would be its voluntary participation by residential property owners. Without this voluntary participation, Glendale's support of the proposed program could not be offered.

On behalf of the City of Glendale, we sincerely appreciate the opportunity to be involved in this important planning process, and request that you keep us fully advised as to the various stages leading up to a final and adopted report by both SEWRPC and MMSD. If you have any further questions, or require any additional information from the City, please advise.

Sincerely,

CITY OF GLENDALE

Richard E. Maslowski

Richard E. Maslowski
City Administrator

mw

cc: Kevin Schaefer, MMSD
Jerome A. Tepper, Mayor
John Fuchs, City Attorney
Collin Johnson, Director of Inspection Services