

A STORMWATER DRAINAGE AND FLOOD CONTROL SYSTEM PLAN FOR GRANTOSA CREEK

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Special acknowledgement is due Michael G. Hahn, SEWRPC Principal Engineer, for his contribution to this report.

**MEMORANDUM REPORT
NUMBER 53**

**A STORMWATER DRAINAGE AND FLOOD CONTROL
SYSTEM PLAN FOR GRANTOSA CREEK**

**CITIES OF MILWAUKEE AND WAUWATOSA
MILWAUKEE COUNTY, WISCONSIN**

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

February 1992

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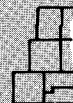
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February 12, 1992

Mr. Patrick Marchese, Director
Public Works and Development Department
Milwaukee County
901 N. 10th Street
Milwaukee, Wisconsin 53223

Dear Mr. Marchese:

In accordance with the terms of the agreement entered into on July 6, 1989, between Milwaukee County and the Regional Planning Commission, the Commission staff, working in cooperation with the staffs of the County and the Cities of Milwaukee and Wauwatosa, has completed a stormwater drainage and flood control system plan for Grantosa Creek. We are pleased to provide to you herewith the report documenting the recommended stormwater drainage and flood control plan for the area concerned.

The plan presented in the report is consistent with regional as well as local land use development and flood control objectives and is intended to serve as a guide to public officials in the making of sound decisions over time concerning the provision of stormwater drainage and flood control within the Grantosa Creek watershed. The report incorporates all the comments offered by County staff based upon the review by that staff of a preliminary draft of the report.

The Regional Planning Commission is particularly appreciative of the contributions of the staffs of Milwaukee County and the Cities of Milwaukee and Wauwatosa during the preparation of the plan. The Commission stands ready to assist the County in securing the adoption of the plan and in promoting its implementation over time.

Sincerely,

Kurt W. Bauer
Executive Director

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SEWRPC Memorandum Report No. 53

A STORMWATER DRAINAGE AND FLOOD CONTROL SYSTEM PLAN
FOR GRANTOSA CREEK

Chapter I

INTRODUCTION

In accordance with the terms of the agreement entered into on July 6, 1989, between Milwaukee County and the Regional Planning Commission, the Commission staff undertook a stormwater drainage and flood control study for Grantosa Creek in the Cities of Milwaukee and Wauwatosa. This memorandum report documents the findings and recommendations of that study. The report defines the problems entailed; describes the alternative plans considered and evaluated, and sets forth a recommended plan for the resolution of the drainage and flood control problems associated with Grantosa Creek. As appropriate, this final report addresses and incorporates review comments on the preliminary draft report which were provided by Milwaukee County staff in their letter of January 6, 1992.

INTERGOVERNMENTAL TASK FORCE ON HAMPTON AVENUE DRAINAGE

An ad hoc intergovernmental task force was formed in 1988 in response to complaints of flooding along Grantosa Creek in the vicinity of W. Hampton Avenue. The task force members included representatives of Milwaukee County and the Cities of Milwaukee and Wauwatosa. During meetings in 1988, the task force considered the drainage and flooding problems existing not only in the immediate area of W. Hampton Avenue, but also along downstream reaches of Grantosa Creek, and agreed to request the Regional Planning Commission to perform a drainage and flood control study on behalf of Milwaukee County.

STUDY AREA DESCRIPTION

As shown on Map 1, the study area encompasses the 1.97 square-mile Grantosa Creek subwatershed, which is a part of the Menomonee River watershed. The

subwatershed boundary and the boundaries of the six subbasins identified for hydrologic analysis within the subwatershed are shown on Map 2.

Grantosa Creek, which is classified as an intermittent stream by the U.S. Geological Survey on the 7.5-minute quadrangle map, begins at the outlet of a 72-inch diameter corrugated metal pipe storm sewer located in Lawrence J. Timmerman Airport in the City of Milwaukee just north of W. Hampton Avenue. Upstream of the 72-inch diameter storm sewer is a network of 10- to 60-inch diameter corrugated metal pipe and vitrified clay pipe storm sewers which drain Timmerman Airport and a small portion of the City of Milwaukee in the area northeast of W. Appleton Avenue. Downstream of the 72-inch diameter outlet, the Creek flows under W. Hampton Avenue in a 110-foot long 10-foot wide by 7.25-foot high reinforced concrete box culvert. The culvert invert is constructed below the existing streambed elevation and is filled to a depth of 2.65 feet, resulting in a clear height of 4.60 feet. Downstream of the box culvert, the stream channel flows in a southerly direction for about 420 feet, passing from the City of Milwaukee to the City of Wauwatosa about 180 feet south of the box culvert outlet. One clear-span pedestrian bridge crosses the Creek just south of the Wauwatosa city limits. The stream then flows in a southerly and then westerly direction for about 1,110 feet through Milwaukee County's Madison Park. The latter reach is located through open park land and, although not designed as such, serves as a detention storage facility which reduces downstream flood flows. There is a low concrete drop structure located across the stream in this reach. At the downstream end of the reach, the Creek enters an 0.70-mile long enclosure located in N. 100th Street, W. Congress Street, N. 99th Street, and W. Grantosa Drive.

The afore-referenced enclosure consists of, from upstream to downstream, 1,415 feet of 84-inch diameter, bituminous-coated, corrugated metal pipe in the City of Wauwatosa; 730 feet of 84-inch diameter, reinforced concrete pipe in the City of Milwaukee; 570 feet of 12-foot wide by 6-foot high reinforced concrete box sewer in the City of Milwaukee; 485 feet of 12-foot wide by 6-foot high reinforced concrete box sewer in the City of Wauwatosa; 225 feet of 14-foot wide by 6-foot high reinforced concrete box sewer in the City of Wauwatosa; and, finally, 280 feet of 14-foot wide by 6-foot high reinforced concrete box sewer in the City of Milwaukee.

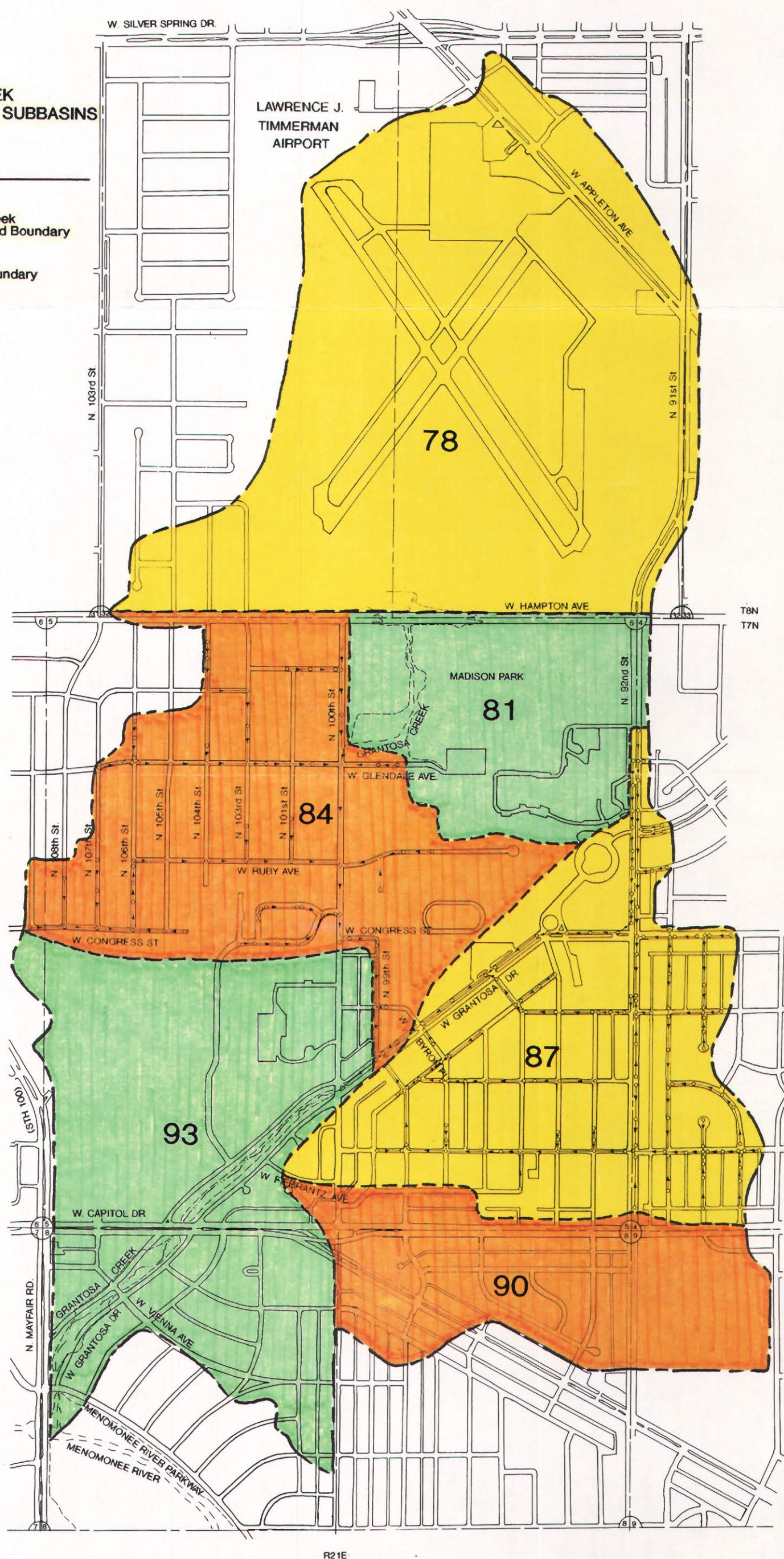
GRANTOSA CREEK SUBWATERSHED SUBBASINS

LEGEND



Grantosa Creek
Subwatershed Boundary

87 Subbasin Boundary and Number



Downstream of the enclosure, the Grantosa Creek channel flows 0.80 mile in a southwesterly direction through Milwaukee County's Grantosa Parkway to its confluence with the Menomonee River. The 0.35-mile long reach of stream from the outlet of the enclosure to W. Capitol Drive is within the City of Milwaukee and the remaining 0.45-mile reach is within the City of Wauwatosa. In the 0.80-mile reach downstream of the enclosure, the Creek is crossed by clear span bridges at W. Capitol Drive and W. Vienna Avenue and flows through a double 12-foot wide by 8.75-foot high reinforced concrete box culvert at Menomonee River Parkway.

The adopted regional land use plan for the design year 2010 reflects the existing land use development pattern in the subwatershed which is virtually totally developed for urban use. Of the total subwatershed area of about 1,261 acres, about 602 acres, or about 48 percent, are in residential uses; about 314 acres, or about 25 percent, are in airport use; about 230 acres, or about 18 percent, are in governmental and institutional uses; about 74 acres, or about 6 percent, are in park and open space uses; about 38 acres, or about 3 percent, are in commercial uses; and about one acre, or less than 1 percent, is in woodland. The existing and planned year 2010 land use pattern is shown on Map 3.

DETERMINATION OF UNIT OF GOVERNMENT WITH JURISDICTION OVER DRAINAGE AND FLOOD CONTROL PROGRAMS FOR GRANTOSA CREEK

This Commission recently completed a drainage and flood control system plan for streams under the jurisdiction of the Milwaukee Metropolitan Sewerage District. That plan is documented in SEWRPC Community Assistance Planning Report No. 152, A Stormwater Drainage and Flood Control System Plan for the Milwaukee Metropolitan Sewerage District, 1991. The criteria for the selection of streams recommended for District jurisdiction for drainage and flood control purposes are set forth in SEWRPC Community Assistance Planning Report No. 130, A Stormwater Drainage and Flood Control Policy Plan for the Milwaukee Metropolitan Sewerage District, March 1986. For an intermittent stream within the District, two of the following three criteria must be met for the stream to be included under District jurisdiction: 1) the District has completed channel improvements for the stream; 2) the stream has significant monetary

flood damage risk; and 3) the stream has a tributary drainage area located in more than one community.

At the time of preparation of the policy plan, it was determined that Grantosa Creek met only one of these three criteria, that of having a tributary drainage area located in more than one community. Therefore, the policy plan did not recommend that Grantosa Creek be included under District jurisdiction for drainage and flood control purposes.

In July 1987, Milwaukee County requested that the District study the causes and solutions to possible flooding problems along Grantosa Creek in the City of Wauwatosa. In an August 6, 1987, response to the County request, the District stated that, because the stream did not meet the criteria for District jurisdiction, flooding problems along the stream would have to be addressed by some other unit of government such as the Cities of Milwaukee and Wauwatosa, or the County.

Also in response to a July 1987 letter from Milwaukee County, this Commission reiterated the policy plan conclusion regarding District jurisdiction and stated that the drainage and flood control system plan then under preparation for the District would consider the effects on Grantosa Creek of backwater from the Menomonee River, but would not address the Creek specifically. The Commission also suggested that the cities concerned, or the County, study the potential flooding problem further, following completion of the District system plan.

The District policy plan was issued and approved prior to the large storms which occurred in August and September of 1986. At the time of the County request in 1987, a comprehensive assessment of the damages in the Grantosa Creek subwatershed caused by the runoff from those storms had not yet been made. As a result, the magnitude of drainage and flood control problems within the subwatershed was not fully known in 1987.

The drainage and flood control study presented here is the only study to systematically and comprehensively inventory historic stormwater drainage and flooding problems in the Grantosa Creek subwatershed, to analyze the severity of those problems using hydrologic and hydraulic simulation techniques, and to

recommend a plan for the alleviation of those problems. As documented later in this report, significant monetary flood damages would be expected to occur in the subwatershed under planned land use and existing channel and drainage conditions. Thus, the second and the third of the three afore-referenced jurisdictional criteria appear to be met.

In addition, based on field observations by County and Commission staff, it may be possible to reclassify the stream as perennial. Such a reclassification could be considered by the U.S. Geological Survey at the request of Milwaukee County. In 1988, Milwaukee County did request the assistance of the U.S. Geological Survey in considering the potential to reclassify Grantosa Creek as a perennial stream. This request is still pending. If reclassified as a perennial stream, satisfaction of only one of the afore-referenced criteria would be needed for the stream to be included under District jurisdiction. Thus, based on the findings of this study, Milwaukee County and the Cities of Milwaukee and Wauwatosa may want to again request that the District assume jurisdiction over Grantosa Creek for drainage and flood control purposes.

If the District were to assume jurisdiction over Grantosa Creek, certain drainage and flood control measures would be eligible for District funding and implementation. If the present status of the Creek regarding jurisdiction for drainage and flood control improvements remains unchanged, any such improvements would have to be paid for, and implemented by, the affected units of local government--including the County--or by private property owners.

HYDROLOGIC AND HYDRAULIC ANALYSES

For the District system plan, hydrologic modeling of the Menomonee River watershed, including the Grantosa Creek subwatershed, was performed by the Regional Planning Commission using the Hydrocomp continuous simulation model. The model simulates streamflow on a continuous basis, using recorded climatological data as input. Stream discharges were computed at 15-minute time intervals over a 49-year period from 1940 through 1988. Peak design flood discharges were developed using the log Pearson type III method to perform discharge-frequency analyses of the annual peak discharges as simulated by the Hydrocomp model. The model was calibrated using data from three continuous recording streamflow gages operated in the watershed by the U.S. Geological Survey in cooperation with the Commission and the Milwaukee Metropolitan Sewerage District.

Those same hydrologic modeling procedures were used for the detailed study of the Grantosa Creek subwatershed presented here. The hydrologic model of the subwatershed used for the District study was further refined by dividing subbasins and modifying routing reaches to provide flood flow estimates at critical locations and to best simulate observed drainage and flooding conditions. For existing channel conditions, those modifications produced no appreciable difference in flood flows along the Menomonee River under existing and planned land use conditions. Therefore, the refined hydrologic model developed for the Grantosa Creek study may be considered to be consistent with the calibrated model developed under the District study and the impacts on the Menomonee River of alternative plans for Grantosa Creek can be evaluated using the refined model.

For both the District system plan and the Grantosa Creek study, hydraulic modeling involving the computation of water surface profiles was performed using the U.S. Army Corps of Engineers HEC-2 backwater simulation model. That model is based on assumptions of gradually varied, steady state flow. Water surface profiles along Grantosa Creek were calculated using starting elevations determined at the Grantosa Creek-Menomonee River confluence using the hydraulic model prepared under the District study.

Because no hydraulic simulation model of Grantosa Creek had been developed under previous planning efforts undertaken by this Commission, or any other agency, the HEC-2 model for Grantosa Creek was developed using data from 1990 topographic maps prepared at a scale of 1 inch equals 100 feet with a 2-foot contour interval. The preparation of these maps was funded by Milwaukee County. Data on bridges and culverts were collected in field surveys conducted by Milwaukee County. Data on storm sewers and channel enclosures were provided by the Cities of Milwaukee and Wauwatosa. A continuous hydraulic model of Grantosa Creek, including both open channel and enclosed portions, was developed for the 1.85-mile long reach of Grantosa Creek from its mouth at the Menomonee River to its source at Timmerman Airport. Based on observations of past performance, the hydraulic computations assumed that about 10 percent of the W. Hampton Avenue box culvert bar rack entrance opening area would be blocked by debris under flood conditions, and that about 25 percent of the N. 100th Street box sewer outfall opening area would be so blocked.

The hydraulic analysis of storm sewers tributary to the enclosed reach of Grantosa Creek was performed using the Hydraflow - Storm Sewers model. The model uses the standard step method to compute hydraulic grade lines in storm sewer networks and can be utilized for pressure flow situations such as those encountered during the course of this study. This model was checked using standard design formula techniques.

DRAINAGE AND FLOODING PROBLEMS

The stormwater drainage system in the Grantosa Creek subwatershed consists of a minor system, designed for more frequent storm events such as a 5- or 10-year recurrence interval storm, and a major system designed for large storm events up to a 100-year recurrence interval storm. The minor drainage system consists of side yard and back yard drainage swales, street curbs and gutters, roadside swales, storm sewers and appurtenances, and storage facilities. The major system consists of the entire street cross section and any interconnected drainage swales, watercourses, and stormwater storage facilities. The plan presented here addresses the components of the major drainage system directly affected by the open channel and enclosed portions of Grantosa Creek, as well as Grantosa Creek itself.

The Regional Planning Commission defines flood control as the prevention of damage from the overflow of natural streams and watercourses, and defines drainage as the control of excess stormwater on the land surface before such water has entered stream channels. In the case of Grantosa Creek, because a significant portion of the stream channel has been enclosed, this distinction between flood control and drainage is obscured. Also, because certain drainage problems are directly related to flood problems due to backwater effects from the receiving streams, the distinction is further obscured. Thus, a given problem may have aspects of both a "drainage" and a "flooding" problem.

Most of the available information regarding observed drainage and flooding problems in the Grantosa Creek subwatershed has been collected since the storms of August 6, 1986, and September 11, 1986. Since those storms, several significant drainage improvement and flood control measures have been undertaken by Milwaukee County, the City of Wauwatosa, and private property owners. Those measures would alleviate some of the drainage and flooding problems

experienced in 1986. The flows simulated for the flood of August 6, 1986, approximated the estimated 100-year recurrence interval flood flows.

A summary of drainage and flooding problems associated with Grantosa Creek and with those components of the major drainage system directly affected by flood levels in Grantosa Creek was compiled from the hydrologic and hydraulic simulations conducted under this study, from an analysis of emergency and complaint calls to the Cities of Milwaukee and Wauwatosa during and after the floods of August and September 1986; from written complaints to Milwaukee County and the City of Wauwatosa; and through personal interviews with residents living along the Creek and the staffs of Milwaukee County and the Cities of Milwaukee and Wauwatosa. Problems were found to be located in five areas along Grantosa Creek. The buildings where drainage or flooding problems related to Grantosa Creek were identified are listed in Table 1 and shown on Map 4.

Vicinity of W. Hampton Avenue

The farthest upstream area where problems have been reported is located in the City of Milwaukee at W. Hampton Avenue. Overtopping of the four-lane arterial street occurs periodically and basement flooding has been reported at four apartment buildings located at 9729, 9733, 9739, and 9815 W. Hampton Avenue. The box culvert under W. Hampton Avenue does not currently have adequate hydraulic capacity to satisfy the Regional Planning Commission recommended criterion that an arterial street not be overtopped during floods with recurrence intervals up to, and including, 50 years. Basement flooding in this area is attributable to a combination of high water levels in the Creek, which is located within about 40 feet of the apartments, and to high water levels adjacent to the apartments due to overtopping of W. Hampton Avenue. The capacity problems of the box culvert are due to a combination of an inadequate existing opening due to the placement of fill in the bottom of the culvert, relatively large hydraulic losses due to the presence of bar racks on the upstream and downstream sides of the culvert, and to the accumulation of debris on the racks. These bar racks are required to prevent unauthorized access to Timmerman Airport; therefore, they cannot be readily removed to improve the hydraulic capacity. The minutes of the January 15, 1988 meeting

Table 1

BUILDINGS ALONG GRANTOSA CREEK WITH IDENTIFIED
DRAINAGE OR FLOODING PROBLEMS^a

Building Number on Map 4	Type of Building	Building Address ^b	Type of Flooding
1	Apartment	9815 W. Hampton Avenue	Secondary
2	Apartment	9739 W. Hampton Avenue	Secondary
3	Apartment	9733 W. Hampton Avenue	Secondary
4	Apartment	9729 W. Hampton Avenue	Secondary
5	Single Family Residence	4527 N. 100th Street	Secondary
6	Single Family Residence	4521 N. 100th Street	Secondary
7	Single Family Residence	4511 N. 100th Street	Secondary
8	Single Family Residence	4504 N. 100th Street	Secondary
9	Single Family Residence	4505 N. 100th Street	Direct
10	Single Family Residence	10209 W. Ruby Avenue	Secondary
11	Single Family Residence	10113 W. Ruby Avenue	Secondary
12	Single Family Residence	10101 W. Ruby Avenue	Direct
13	Single Family Residence	10051 W. Ruby Avenue	Direct
14	Single Family Residence	10043 W. Ruby Avenue	Direct
15	Single Family Residence	10033 W. Ruby Avenue	Direct
16	Single Family Residence	9919 W. Ruby Avenue	Secondary
17	Single Family Residence	9949 W. Grantosa Drive	Secondary
18	Single Family Residence	9943 W. Grantosa Drive	Direct
19	Single Family Residence	9937 W. Grantosa Drive	Direct
20	Single Family Residence	9929 W. Grantosa Drive	Direct
21	Single Family Residence	9925 W. Grantosa Drive	Direct
22	Single Family Residence	9917 W. Grantosa Drive	Direct
23	Single Family Residence	9845 W. Grantosa Drive	Secondary
24	Single Family Residence	9839 W. Grantosa Drive	Secondary
25	Single Family Residence	9812 W. Palmetto Avenue	Secondary
26	Single Family Residence	9732 W. Palmetto Avenue	Secondary
27	Single Family Residence	10123 W. Fiebrantz Avenue	Secondary
28	Single Family Residence	10114 W. Fiebrantz Avenue	Secondary
29	Single Family Residence	10046 W. Fiebrantz Avenue	Secondary
30	Single Family Residence	10147 W. Fiebrantz Avenue	Secondary
31	Single Family Residence	10119 W. Fiebrantz Avenue	Secondary
32	Single Family Residence	10109 W. Fiebrantz Avenue	Secondary
33	Single Family Residence	10711 W. Grantosa Drive	Direct Yard and Garage








^aIncluded in this table are those buildings with identified drainage or flooding problems associated directly with overflow from Grantosa Creek or with components of the major stormwater drainage system which are directly affected by flood stages in Grantosa Creek.

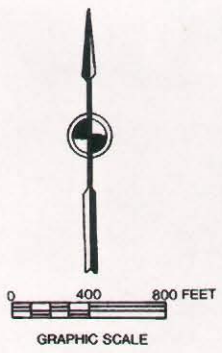
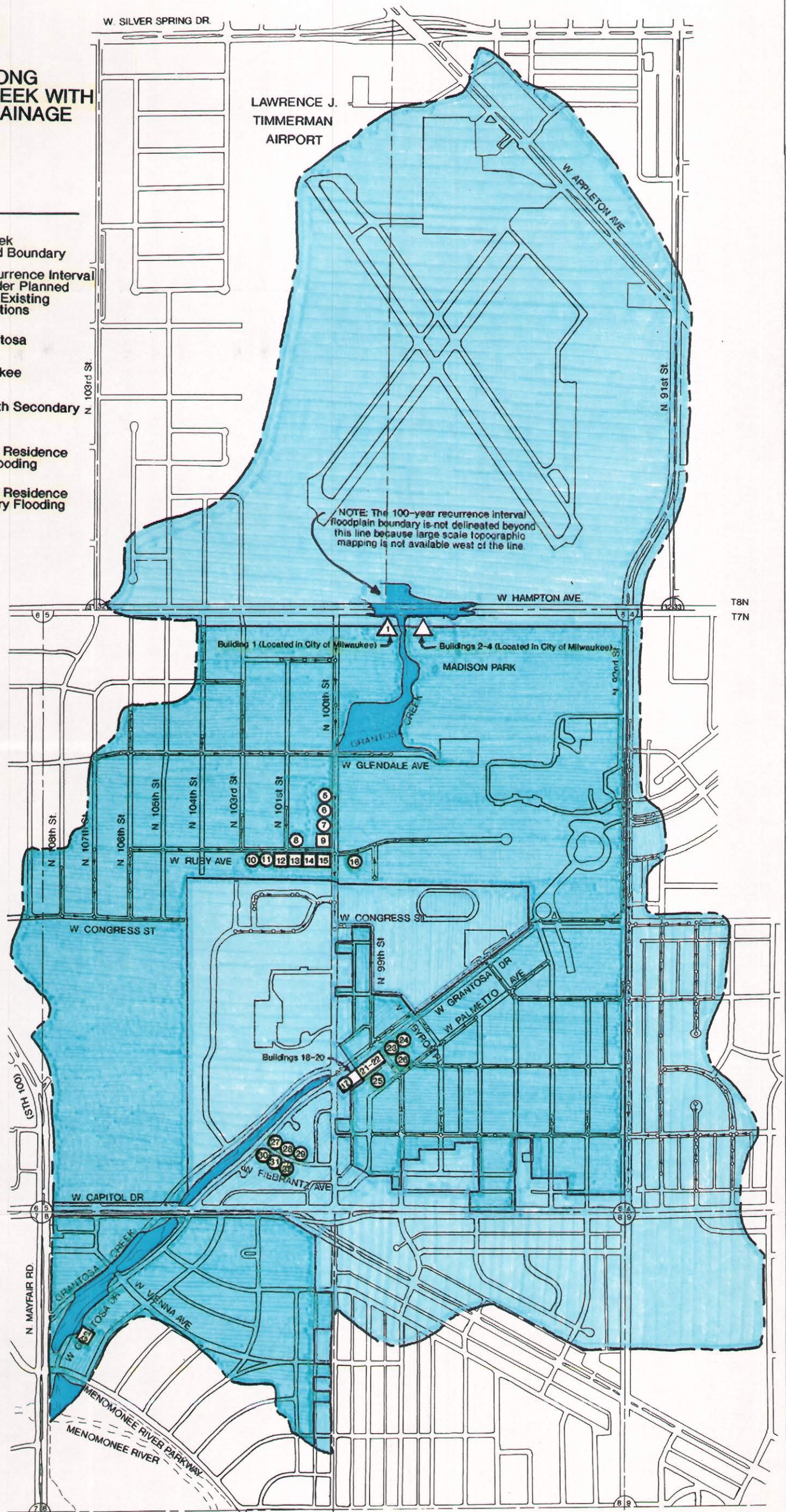
^bBuildings 1 through 4, 17 through 20, and 27 through 32 are located in the City of Milwaukee. Buildings 5 through 16, 21 through 26, and 33 are located in the City of Wauwatosa.

MAP 4

BUILDINGS ALONG GRANTOSA CREEK WITH IDENTIFIED DRAINAGE OR FLOODING PROBLEMS

LEGEND

-  Grantosa Creek Subwatershed Boundary
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Existing Channel Conditions
-  City of Wauwatosa
-  City of Milwaukee
-  Apartment With Secondary Flooding
-  Single-Family Residence With Direct Flooding
-  Single-Family Residence With Secondary Flooding



of the intergovernmental task force on Hampton Avenue drainage refer to three feet of fill in the W. Hampton Avenue culvert. The culvert was apparently constructed with its bottom three feet below the streambed in anticipation that the streambed would be lowered in the future for stormwater drainage purposes. Such construction is common in the Milwaukee area in situations where future lowering of the streambed has been envisioned. A drainage alternative which would involve lowering the streambed within, and downstream of, the culvert was set forth in a January 11, 1973, letter from the City of Milwaukee Sewer Engineering Division to the Wauwatosa City Administrator.

In 1988, the owner of the apartments at 9729 and 9733 W. Hampton Avenue undertook floodproofing measures, consisting of the installation of foundation drains and sump pumps. According to the owner, those measures have alleviated basement flooding. Since the measures were installed, there has been at least one flood of sufficient magnitude to cause flooding of W. Hampton Avenue.

Vicinity of N. 100th Street and W. Ruby Avenue

The next downstream area where problems have been reported is located along the enclosed portion of the channel in the City of Wauwatosa in the vicinity of N. 100th Street and W. Ruby Avenue. In August of 1986, basement flooding problems were reported at ten single-family residences in that area,¹ with nine of the ten affected residences being located west of N. 100th Street. Flood hazard mapping prepared under this study indicates the potential for direct flooding of at least two additional residences in this area during a 100-year recurrence interval flood under planned land use and existing channel conditions.

There is a sag in the grade of W. Ruby Avenue about 300 feet west of N. 100th Street. Runoff in excess of the capacity of the storm sewers ponds in and

¹Buildings 5, 6, 7, 8, 10, 11, 12, 13, 14, and 16, as listed in Table 1 and shown on Map 4. Building 15 was not constructed as of August 6, 1986.

around this sag and floods the adjacent yards and houses. Local runoff from the west also collects in the back yards of houses along the south side of W. Ruby Avenue west of N. 100th Street. Another contributing factor to flooding in this area is overflow into W. Glendale Avenue, and then into

N. 100th Street, of runoff at a rate in excess of the capacity of the storm sewer inlet at the upstream end of the channel enclosure.

During a 100-year recurrence interval flood under planned land use and existing drainage and channel conditions, runoff may be expected to pond in the sag in the street grade up to the elevation of the intersection of N. 100th Street and W. Congress Street, which intersection is located about 650 feet to the south. Overtopping of that intersection then provides an outlet for additional runoff, limiting the ultimate height of ponding. Based on mapping of flood hazard areas under this study, it appears that past flooding of buildings may have occurred in the vicinity of N. 100th Street and W. Ruby Avenue due to either secondary flooding caused by inflow to basements through joints and cracks in the foundation walls and through sanitary sewer backups, or to direct overland flooding through basement windows.

Since the 1986 floods, the City of Wauwatosa in cooperation with Milwaukee County has reduced the potential for flooding in this area by providing additional hydraulic capacity at the 100th and Glendale storm sewer inlet. The Wauwatosa Engineering Department determined that the 84-inch diameter storm sewer in N. 100th Street was only flowing half full at the time of the street flooding which occurred along N. 100th Street and W. Ruby Avenue on August 6, 1986. Therefore, additional capacity was provided at the inlet through the installation of two 36-inch diameter corrugated metal pipes, both of which discharge to the storm sewer, and through the elimination of the bar rack at the inlet. This increase in the hydraulic capacity of the inlet has reduced the probability of overflow into W. Glendale Avenue and N. 100th Street which in turn drains to the sag in the grade of W. Ruby Avenue. A conflicting observation to that of City of Wauwatosa staff was made on August 6, 1986, by

Milwaukee County park staff who observed manhole covers being lifted on surcharged sewers in the vicinity of the inlet to the 84-inch diameter storm sewer.²

An additional stormwater drainage improvement which was provided in this area in August of 1988 through a cooperative effort of property owners and the City of Wauwatosa, was the installation of two stormwater inlets along with 161 feet of 18-inch diameter and 28 feet of 24-inch diameter reinforced concrete storm sewer, running from a depression in a backyard along the south side of W. Ruby Avenue to the existing 48-inch diameter reinforced concrete storm sewer in W. Ruby Avenue. This new storm sewer facilitates drainage of local runoff ponding in the back yards along W. Ruby Avenue.

The storm of August 6, 1986, also resulted in drainage problems in the vicinity of N. 106th Street and W. Congress Street, about 0.33 mile west of the Grantosa Creek enclosure. Since 1986, the City of Wauwatosa has taken measures to improve both the major and minor drainage systems in that area. Improvements to the major drainage system include the provision of detention storage in a ditch along the south side of W. Congress Street and replacement of about 150 feet of curb and gutter. Improvements to the minor drainage system include the addition of storm inlets along N. 106th Street and along W. Congress Street between N. 106th Street and N. 108th Street.

²During the course of the study presented here, an evaluation was made of the hydraulic capacity of the entire main storm sewer running from the intersection of W. Glendale Avenue and N. 100th Street to the intersection of W. Grantosa Drive and N. 100th Street. It was determined that the existing capacity of this storm sewer is less than that required to carry the 10-year recurrence interval flood flow. Thus lack of capacity in the main sewer causes surcharging of the tributary storm sewer system along W. Ruby Avenue west of N. 100th Street. The surcharging is caused by the high hydraulic grade line in the main storm sewer at its junction with the W. Ruby Avenue sewer. Except for the surcharging of the tributary sewer, the 0.70 mile-long main storm sewer can convey the 25-year flood flow without overtopping W. Glendale Avenue and N. 100th Street at the entrance to the sewer and without backflow out of inlets or manholes.

W. Grantosa Drive Between N. 100th Street and W. Byron Place

A third area of reported problems is located along W. Grantosa Drive in the Cities of Milwaukee and Wauwatosa between N. 100th Street and W. Byron Place. This is also a reach of enclosed channel. Based on reports to the City of Wauwatosa and the testimony of area residents, seven instances of basement flooding and damage and one case of first-floor flooding were identified with respect to the flood of August 6, 1986.³ These involved single-family residences in the area. Flood hazard mapping undertaken under this study indicates the potential for direct basement flooding of at least two additional residences in this area during a 100-year recurrence interval flood under planned land use and existing channel conditions. Runoff in excess of the storm sewer capacity may be expected to pond in a mid-block sag in the grade of W. Grantosa Drive located about 160 feet east of N. 100th Street. North 100th Street would effectively act as a dam, backing up excess runoff until the street would be overtopped at approximate elevation 709.2 feet National Geodetic Vertical Datum (NGVD). Flow over N. 100th Street would then enter the open channel portion of Grantosa Creek.

The potential for flooding of this area was reduced in late 1989 through the removal by Milwaukee County of up to about 2.5 feet of sediment which had accumulated in the Grantosa Creek channel downstream of the enclosure outfall at N. 100th Street. The removal of that sediment provided a more efficient outlet for the 14-foot wide by 6-foot high reinforced concrete box storm sewer.

Intersection of W. Grantosa Drive and W. Fiebrantz Avenue

Another area of reported flooding is located around the intersection of W. Grantosa Drive and W. Fiebrantz Avenue in the City of Milwaukee. This intersection is located about 80 feet from Grantosa Creek. According to testimony of area residents, secondary flooding of approximately six basements occurred due to sanitary sewer backup during the flood of August 6, 1986.⁴ Residents of the area also reported flooding of the intersection due to

³Basement flooding and damage at buildings 17, 18, 21, 23, 24, 25, and 26, as listed in Table 1 and shown on Map 4. First floor flooding of building 19.

⁴Buildings 25 through 30 as listed in Table 1 and identified on Map 4.

surcharging of the storm sewer in W. Fiebrantz Avenue caused by high water levels in Grantosa Creek. Local runoff from yards in excess of the capacity of sump pumps and sump pump failure were also mentioned as sources of basement flooding.

It is not feasible within the scope of a system planning effort to make a definitive determination of the causes of basement flooding due to sanitary sewer backup. Those causes may include clearwater inflow connections from buildings to the sanitary sewer, excessive clearwater infiltration into the sanitary sewer, clearwater inflow to the sanitary sewer due to ponded water entering through unsealed manholes, and backup from connecting sewers that are surcharged. It is recommended that a second level study of the sanitary sewer system be made to locate potential sources of clearwater inflow, or backup of surcharged downstream sewers in the vicinity of the intersection of W. Grantosa Drive and W. Fiebrantz Avenue. Any sources of clearwater inflow should be disconnected and manholes should be sealed. If downstream surcharging were determined to be a problem, major sewer system rehabilitation would probably be required. If measures to reduce sanitary sewer infiltration and inflow are not completely effective, property owners should consider installation of backwater check valves in the sanitary sewer house connections. Additional measures to address local yard runoff problems might include the provision of greater sump pump capacity and standby power sources for sump pumps.

W. Grantosa Drive Between W. Capitol Drive and Menomonee River Parkway

The farthest downstream area where flooding problems have been identified is located along the southeast side of W. Grantosa Drive from about 650 to 950 feet upstream of the mouth of Grantosa Creek. The owner of the house at 10711 W. Grantosa Drive reported that, during the flood of August 6, 1986, Grantosa Creek overflowed its banks, the floodwaters crossed W. Grantosa Drive, and rose to an elevation within about two inches of the elevation of the front door threshold of his house and to within four inches of the elevation of the basement windows of the next house to the southwest, located at 10727 W. Grantosa Drive. The flooding in this reach was aggravated by a partial blockage of the Menomonee River Parkway double box culvert with an 8-foot by 4-foot piece of plywood. The level of flooding which was reported was verified in the hydrologic and hydraulic simulation modeling.

The houses at 10727 and 10661 W. Grantosa Drive have backwater check valves installed in their sanitary sewer house connections. The owner of the house at 10727 stated that he had experienced no basement flooding since installation of the backwater check valve and a sump pump about 18 years ago. The house at 10711 W. Grantosa Drive has no basement and, therefore, only the front yard and a portion of the attached garage experienced shallow flooding on August 6, 1986. No monetary damages were reported.

Personal interviews were conducted with the owners of four houses located along Grantosa Parkway near its intersection with W. Vienna Avenue.⁵ The owners reported front yard flooding in the area on August 6, 1986, but no basement flooding due to the overflow of the Creek or to sanitary sewer backup. They also reported no significant flooding problems due to overflow from Grantosa Creek or to sewer backup on other occasions.

DETERMINATION OF MONETARY FLOOD DAMAGES

Flood profiles for planned land use and existing channel conditions are shown on Figure 1 in Chapter III. Those flood profiles were used to estimate the flooding of buildings which may be expected during floods of various recurrence intervals. In addition, information obtained from the Cities of Milwaukee and Wauwatosa and from personal interviews with eight residents and one apartment owner was used to identify buildings near Grantosa Creek which have been subject to secondary flooding of basements.⁶ Because of the many site-specific factors which can be the cause of secondary flooding, its occurrence cannot be reliably predicted unless it has been observed and documented in the past. Therefore, there may be some additional buildings which have also experienced secondary flooding, but for which the flooding was not reported by the owners.

⁵Interviews were conducted with the residents of 10524, 10544, 10552, and 10560 W. Grantosa Drive.

⁶Interviews were conducted with the residents of 10524, 10544, 10552, 10560, 10711, and 10727 W. Grantosa Drive, the residents of 10046 and 10106 W. Fiebrantz Avenue, and the owner of the apartments at 9729, 9733, and 9739 W. Hampton Avenue.

Because determination of the exact causes of the secondary flooding, including primarily sanitary sewer backup, in the vicinity of W. Fiebrantz Avenue and W. Grantosa Drive is beyond the scope of a systems level drainage and flood control plan such as this, no specific remedial measures are recommended and the potential damages which could be incurred in that area under flood conditions are not included in the damage estimate for the study area.

The costs of flooding were estimated using damage cost curves prepared by the Regional Planning Commission. Such curves relate the dollar amount of the flood damages--including damages to the building and to its contents--to the depth of inundation and to the estimated market value of the buildings involved. Indirect damages were separately estimated. Such damages include the monetary costs of evacuation, relocation, lost wages, road and highway detours, and flood fighting and emergency services.

The analyses conducted indicate that, during a 100-year recurrence interval flood under planned land use and existing channel conditions, there are 10 buildings which may be expected to be flooded directly, and 16 buildings which may be expected to be affected by secondary flooding.⁷ The 26 buildings are located in areas immediately adjacent to the open channel and enclosed reaches of Grantosa Creek and along reaches of the major stormwater drainage system which are directly affected by flood levels in Grantosa Creek. Total damages due to both direct and secondary flooding of buildings under a 100-year recurrence interval flood event may be expected to approximate \$210,000. The average annual flood damages may be expected to approximate \$12,300.

The estimated average annual flood damages per unit stream length along Grantosa Creek were compared to estimated damages along other streams in Milwaukee County as determined under SEWRPC Community Assistance Planning Report No. 152, A Stormwater Drainage and Flood Control System Plan for the Milwaukee Metropolitan Sewerage District, which was published in December of 1990.

⁷These include all of the buildings listed in Table 1 and shown on Map 4, except for the six buildings along W. Fiebrantz Avenue, which are excluded for reasons set forth above, and the building at 10711 W. Grantosa Drive, which would not be expected to incur significant monetary flood damages.

Based on that comparison, it was concluded that the estimated unit annual flood damages for Grantosa Creek lie in the middle range of damages along streams in the Milwaukee area. The Grantosa Creek damages are considerably less than along streams with high damage potential such as Lincoln Creek in the City of Milwaukee, or the Edgerton Channel in the City of Cudahy, but considerably more than along streams with low damage potential such as the Little Menomonee River in the City of Milwaukee or Beaver Creek in the Village of Brown Deer.

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Chapter II

ALTERNATIVE STORMWATER DRAINAGE AND FLOOD CONTROL SYSTEM PLANS

Four alternative drainage and flood control plans were considered under this study. Each alternative is briefly described in this chapter. The flood flows along Grantosa Creek under each alternative are given in Table 2. The estimated costs of the alternative drainage and flood control systems and a listing of the advantages and disadvantages of each alternative are set forth in Table 3.

ALTERNATIVE NO. 1--MAXIMUM DETENTION STORAGE AND ADDITIONAL STORM SEWER CAPACITY

As shown in graphic summary form on Map 5, this alternative would provide for the construction of two dry detention basins on Milwaukee County property, one north of W. Hampton Avenue at Timmerman Airport, and the other northeast of the intersection of N. 100th Street and W. Glendale Avenue in Madison Park. During a 100-year recurrence interval flood event under planned land use and channel conditions, the Timmerman basin would have a storage capacity of about 29 acre-feet and the Madison basin would have a storage capacity of about 11 acre-feet. Both basins would utilize existing hydraulic structures as outlets, with the Timmerman basin discharging through the W. Hampton Avenue box culvert and the Madison basin discharging through the existing 84-inch diameter, bituminous-coated, corrugated metal storm sewer supplemented by the two existing 36-inch diameter, corrugated metal pipe inlets.

The Timmerman detention basin would reduce downstream 100-year recurrence interval flood flows sufficiently so that only relatively minor localized ponding would occur to a maximum depth of about 0.6 foot in the westbound lanes of W. Hampton Avenue. In addition, 100-year recurrence interval flood stages in the 190-foot long reach downstream of W. Hampton Avenue would be reduced from 1.0 to 1.4 feet in comparison to existing channel conditions, further decreasing the potential for secondary basement flooding of the apartments in this reach.

Table 2

COMPARISON OF FLOOD FLOWS IN GRANTOSA CREEK

River Mile	Flood Recurrence Interval (years)	Flow (cfs)				
		Planned (2010) Land Use, ^a and Existing Drainage and Channel Conditions	Alternative 1 Planned (2010) Land Use and Planned Drainage and Channel Conditions	Alternative 2 Planned (2010) Land Use and Planned Drainage and Channel Conditions	Alternative 3 Planned (2010) Land Use and Planned Drainage and Channel Conditions	Alternative 4 Planned (2010) Land Use and Planned Drainage and Channel Conditions
0.0	100	1,100	960	1,010	1,170	1,100
Mouth of	50	960	840	890	1,020	960
Grantosa Creek	25	830	720	780	870	830
	10	660	580	630	690	660
	2	370	320	360	380	370
0.80	100	740	640	690	890	740
N. 100th Street	50	660	570	620	770	660
Storm Sewer	25	590	500	550	670	590
Outlet	10	490	410	460	540	490
	2	300	240	280	300	300
0.898	100	510	410	470	650	510
Along Enclosure at	50	460	360	420	570	460
Intersection of	25	420	320	370	500	420
N. 99th Street and	10	350	260	310	400	350
W. Grantosa Drive	2	220	150	200	220	220
1.51 ^b	100	350	200	200	510	350
N. 100th Street	50	310	170	190	440	310
Storm Sewer Inlet	25	270	150	170	370	270
	10	230	110	150	290	230
	2	140	60	110	150	140
1.72	100	390	240	390	390	390
North Boundary	50	320	170	320	320	320
of Madison Park	25	260	120	260	260	260
	10	200	80	200	200	200
	2	100	30	100	100	100

^aThe adopted regional land use plan for the design year 2010 reflects the existing land use development pattern in the subwatershed, which is virtually totally developed for urban use.

^bFlows are less than at River Mile 1.72 due to storage in Madison Park.

Table 3

PRINCIPAL FEATURES, COSTS, ADVANTAGES, AND DISADVANTAGES OF ALTERNATIVE DRAINAGE AND FLOOD CONTROL PLANS
FOR GRANTOSA CREEK IN THE CITIES OF MILWAUKEE AND WAUWATOSA^a

No.	Name	Description	Capital	Costs		Average Annual Cost	Benefit -Cost Ratio ^c	Key Considerations	
				Amortized Capital ^b	Operation and Maintenance			Advantages	Disadvantages
1.	Maximum Detention Storage and Additional Storm Sewer Capacity	a. 29-acre-foot Timmerman Airport Detention Basin	\$ 808,000		\$ 7,000			o Construction on public property or rights-of-way enhances implementability	o High capital and average annual costs
		b. 11 acre-foot Madison Park	654,000		3,000			o Minimal disturbance of existing stream channel	o Localized ponding of runoff could occur in westbound lanes of W. Hampton Avenue during a 100-year flood
		c. Storm Sewers, Inlets, and Backwater Gates	562,000		300			o Reduces downstream flows in Grantosa Creek in comparison with existing condition	o Temporary reduction of parkland available for active recreation during periodic shallow inundation in detention area
								o Detention basins could be modified to provide water quality benefits if permanent ponds on and near the airfield were acceptable	o Elimination of planned park uses, including building construction
								o Could enhance aesthetic characteristics of Madison Park	
Total			\$2,024,000	\$128,500	\$10,300	\$138,800	0.09		
2.	Detention Storage with Additional Storm Sewer Capacity and Limited Channel Modification	a. 2.3 acre-foot Madison Park Detention Basin	775,000		6,500			o Construction on public property or rights-of-way enhances implementability	o Requires construction in channel which may cause problems with erosion and sedimentation
		b. Channel Modification	111,000		500			o Second lowest capital and annual costs of all four alternatives	o Temporary reduction of parkland available for active recreation during periodic shallow inundation in detention area
		c. Storm Sewers, Inlets, and Backwater Gates	562,000		300			o Minimal disturbance of most of existing stream channel	o Elimination of planned park uses, including building construction
								o Improves aesthetic characteristics of upper reach of Grantosa Creek	o Requires procurement of drainage easements
								o Reduces flows in Grantosa Creek in comparison with existing condition	
								o Detention basins could be modified to provide water quality benefits if a permanent pond near the airfield were acceptable	
								o Could enhance aesthetic characteristics of Madison Park	
Total			\$1,448,000	\$ 91,900	\$ 7,300	\$ 99,200	0.12		

Table 3 (continued)

No.	Name	Description	Capital	Amortized Capital ^b	Costs Annual Operation and Maintenance	Average Annual Cost	Benefit -Cost Ratio ^c	Key Considerations	
								Advantages	Disadvantages
3.	Additional Storm Sewer Capacity With Existing Detention Storage and Limited Channel Modification	a. Parallel 84-inch diameter Storm Sewer in N. 100th Street b. Storm Sewers, Inlets, and Backwater Gates c. Channel Modification d. Purchase of one house	\$2,210,000 437,000 112,000 125,000		\$1,500 200 500			<ul style="list-style-type: none"> o Construction on public property or rights-of-way enhances implementability o Minimal disturbance of most of existing stream channel o Improves aesthetic characteristics of upper reach of Grantosa Creek 	<ul style="list-style-type: none"> o Highest capital and annual costs of all four alternatives o Requires legal arrangements with downstream property owners due to increases in flows and stages in Grantosa Creek in comparison with existing condition o Increases flow velocities and bank erosion and bed scour o Requires procurement of drainage easements
Total			\$2,884,000	\$183,100	\$2,200	\$185,300	0.07		

^aBecause of certain perceived disadvantages attendant to a floodproofing approach to the resolution of drainage and flooding problems along Grantosa Creek, that alternative was not considered to be directly comparable to the other alternatives. Thus, the structure floodproofing and elevation alternative is not included in this table.

^bAmortized capital cost is based on an interest rate of 6 percent and a project life of 50 years.








^cAverage annual flood damages abatement benefit is estimated to be \$12,300.

Source: SEWRPC

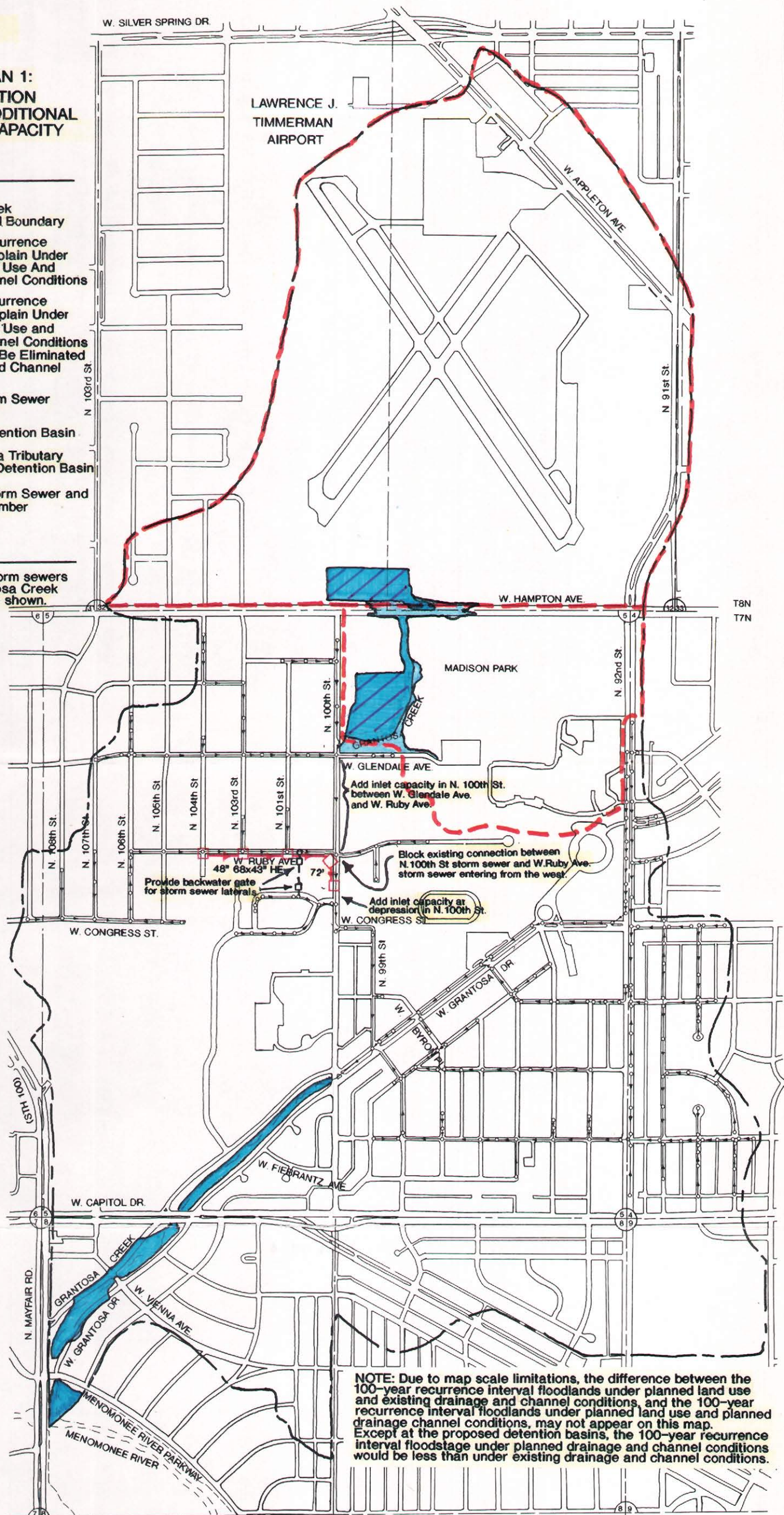
MAP 5

ALTERNATIVE PLAN 1: MAXIMUM DETENTION STORAGE AND ADDITIONAL STORM SEWER CAPACITY

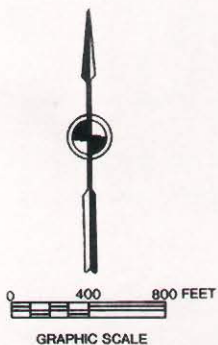
LEGEND

-  Grantosa Creek Subwatershed Boundary
-  100-Year Recurrence Interval Floodplain Under Planned Land Use And Planned Channel Conditions
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Existing Channel Conditions Which Would Be Eliminated Under Planned Channel Conditions
-  Existing Storm Sewer and Manhole*
-  Proposed Detention Basin
-  Drainage Area Tributary To Proposed Detention Basin
-  Proposed Storm Sewer and Junction Chamber

* Only those existing storm sewers tributary to the Grantosa Creek channel enclosure are shown.



NOTE: Due to map scale limitations, the difference between the 100-year recurrence interval floodlands under planned land use and existing drainage and channel conditions, and the 100-year recurrence interval floodlands under planned land use and planned drainage channel conditions, may not appear on this map. Except at the proposed detention basins, the 100-year recurrence interval floodstage under planned drainage and channel conditions would be less than under existing drainage and channel conditions.



The Madison Park detention basin, in conjunction with the Timmerman basin, would reduce the 100-year recurrence interval flood flows sufficiently so that overflow from the Creek would not enter W. Glendale Avenue and flow south down N. 100th Street to pond at the intersection of N. 100th Street and W. Ruby Avenue.

Wet detention basins with a permanent pond to control runoff of nonpoint source pollutants from areas of urban development could be constructed at the sites proposed for detention; however, they could create a potential aviation safety hazard by attracting water fowl to Timmerman Airport and a potential safety hazard to children from Madison Elementary School, which is located adjacent to Madison Park. Therefore, dry basins, which would drain completely between flood events, are proposed.

Although overflow from Grantosa Creek, would be eliminated as a source of flooding at the intersection of N. 100th Street and W. Ruby Avenue, local runoff in excess of the capacities of the existing storm sewers which are tributary to the enclosure would still pond near the intersection, creating a potential for flooding of houses. The potential for flooding under 100-year recurrence interval flood events could be eliminated through the construction of a parallel relief sewer in W. Ruby Avenue, west of N. 100th Street; through the installation of a backwater gate in a storm sewer which conveys local runoff; and through the addition of storm inlet capacity in N. 100th Street.

As shown on Map 5, the relief storm sewer would consist of 260 feet of 72-inch diameter reinforced concrete pipe, 905 lineal feet of 68-inch wide by 43-inch high horizontal elliptical (H.E.) reinforced concrete pipe, and 390 feet of 48-inch diameter reinforced concrete pipe. Junction boxes to accommodate the existing and proposed storm sewers would be provided at the locations of existing manholes. The connection between the existing 48-inch diameter storm sewer in W. Ruby Avenue and the 84-inch diameter storm sewer in N. 100th Street would be blocked and a junction chamber would be provided to combine the flow from the proposed 68-inch by 43-inch H.E. sewer and the existing 48-inch sewer into the proposed 72-inch sewer which would discharge to the existing 84-inch sewer in N. 100th Street at the corporate boundary between the Cities of Milwaukee and Wauwatosa.

The rerouting of the existing 48-inch sewer and the addition of the 72-inch sewer would be necessary in order to reduce hydraulic losses to a degree which would not cause flooding due to storm sewer backup into W. Ruby Avenue under 100-year recurrence interval flood conditions. If runoff from W. Ruby Avenue were discharged to the 84-inch diameter, bituminous-coated, corrugated metal pipe at the intersection of 100th and Ruby, the hydraulic grade line elevation in the 84-inch pipe at the intersection would be so high that backflow out of storm sewer inlets, and attendant flooding, would occur along W. Ruby Avenue.

To insure that runoff in excess of the capacities of the storm sewers which are located north of W. Ruby Avenue and are tributary to the enclosure in N. 100th Street does not pond in the vicinity of N. 100th Street and W. Ruby Avenue, it is recommended that additional inlet capacity be provided in N. 100th Street between W. Glendale and W. Ruby Avenues in the City of Wauwatosa. It is also recommended that additional inlets be provided at the sag in the grade line of N. 100th Street, which is located in the City of Milwaukee about 100 feet north of the intersection of N. 100th Street and W. Sharon Lane. The additional inlets would intercept runoff in excess of the capacity of the upstream storm sewers under 100-year flood conditions and convey that runoff to the 84-inch diameter storm sewer. That storm sewer has adequate hydraulic capacity to convey the additional flow.

An existing storm sewer runs north from a low point in the back yards between the houses at 10033 and 10043 W. Ruby Avenue to the existing 48-inch diameter storm sewer in Ruby Avenue in the City of Wauwatosa. Another existing storm sewer runs south from the back yards along Ruby Avenue into an existing 36-inch diameter storm sewer in W. Sharon Lane in the City of Milwaukee. These two storm sewers are the only outlets for local runoff from the west which collects in the yards of houses along W. Ruby Avenue. Under 100-year recurrence interval flood conditions, the hydraulic grade line in the existing and proposed W. Ruby Avenue storm sewers and the existing Sharon Lane storm sewer may be expected to be at a level which could cause yard flooding of the house along the south side of W. Ruby Avenue due to the flood waters backing up through the back yard storm sewer. It is, therefore, recommended that automatic backwater gates be installed in the two back yard storm sewers near their junctions with the storm sewers in W. Ruby Avenue and W. Sharon Lane. The gates would permit the sewers to function to drain ponded water from the

back yards during and after flood events, but would prevent waters from the Ruby Avenue and Sharon Lane storm sewers from backing up into the yards.

It is possible that landscaping measures to raise the grade or provide an earthen berm around part of the house at 10033 W. Ruby Avenue could be substituted for the installation of backwater gates in the storm sewer lines running from the back yards to W. Ruby Avenue and W. Sharon Lane. That option could be selected based on local preference. The details of such landscaping measures would have to be determined in final design.

This alternative would eliminate overflow from Grantosa Creek at N. 100th Street and W. Glendale Avenue. It would also eliminate overflow from the intervening area along the channel enclosure. If not eliminated, that overflow would ultimately pond east of the intersection of N. 100th Street and W. Grantosa Drive, aggravating potential flooding problems in that area.

Under this alternative, flooding of buildings in the area east of the intersection of N. 100th Street and W. Grantosa Drive would be eliminated for floods up to and including the 100-year recurrence interval event under planned land use and proposed drainage and channel conditions. This abatement of flooding would be achieved by a combination of factors including the elimination of upstream overflow, the improved hydraulic capacity of the enclosure outlet due to excavation of the Grantosa Creek channel by Milwaukee County, and the reduction in peak flow rates resulting from the proposed upstream detention storage. Minor localized ponding could be expected to continue to occur at a sag in the grade of W. Grantosa Drive located about 160 feet east of the intersection of N. 100th Street and W. Grantosa Drive. That ponding should only affect one of the four traffic lanes and should not submerge nearby sanitary sewer manhole covers. Therefore, secondary flooding due to sanitary sewer backup caused by infiltration through the manholes would not be expected.

As already noted in the preceding chapter, because all of the causes of the secondary flooding in the vicinity of the intersection of W. Grantosa Drive and W. Fiebrantz Avenue cannot be determined under a systems level study, no specific measures to alleviate such flooding are included in this alternative. It is recommended that a second level study be made of the sanitary sewer

system in that area in order to locate and eliminate potential sources of inflow and infiltration.

Utilizing an annual interest rate of 6 percent and a project life and amortization period of 50 years, the average annual cost of this alternative plan is estimated at \$138,800. This cost consists of the amortization of the \$2,024,000 capital cost and \$10,300 in annual operation and maintenance costs. The average annual flood damage abatement benefit is estimated at \$12,300, yielding a benefit-cost ratio of 0.09. Annual operation and maintenance costs consist of maintenance of the basin inlet and outlet, administration of the maintenance program, basin inspection, nuisance control, general lawn care, and lawn mowing. Because dry basins with no permanent pond are proposed, significant sediment accumulation would not be anticipated and no costs are assigned for sediment removal.

ALTERNATIVE NO. 2--DETENTION STORAGE WITH ADDITIONAL STORM SEWER CAPACITY AND LIMITED CHANNEL MODIFICATION

This alternative is a variation of Alternative No. 1. The differences between the two alternatives arise from the elimination of the dry detention basin in Timmerman Airport north of W. Hampton Avenue. As shown on Map 6, this alternative would provide for the construction of one dry detention basin on Milwaukee County property northeast of the intersection of N. 100th Street and W. Glendale Avenue in Madison Park. The basin would discharge through the existing storm sewers at the inlet to the Grantosa Creek enclosure. During a 100-year recurrence interval flood event under planned land use and channel conditions, the basin would have a capacity of about 23 acre-feet. The existing channel through the basin site would be maintained to convey low flows, but the right overbank, looking in the downstream direction, would be excavated to construct the basin. Temporary inundation of the right overbank to a depth of a few inches could be expected about once every two years.

In place of the Timmerman detention basin, the 2.65 feet of backfill in the bottom of the W. Hampton Avenue box culvert would be removed and 0.24 mile of the Grantosa Creek channel would be lowered and widened to meet the lowered streambed elevation at W. Hampton Avenue. The channel modification would terminate at the site of the existing drop structure in Madison Park and the

drop structure would be removed. As shown on Figure 3 in Chapter III, the modified channel would consist of a low-flow channel and a flood control channel. The riprap-lined low-flow channel would meander along the existing low-flow channel alignment and would be about one foot deep. The bottom width would vary from one to four feet and the top width would vary from three to eight feet. The flood control channel would be lined with natural vegetation and would have a bottom width varying from 5 to 20 feet. Flood control channel side slopes would average one vertical on three horizontal, but could be varied to produce a more natural looking channel, as shown on Figure 3. Although the available space is limited in the 400-foot long reach of channel just south of W. Hampton Avenue, the channel alignment could be varied to produce a more aesthetic and natural-looking stream than under existing conditions. As shown on Figure 2 in Chapter III, in Madison Park the low flow channel could be constructed to meander within a flood control channel with a bottom width of about 20 feet. Erosion protection would be required on the channel banks in the reach between W. Hampton Avenue and the pedestrian bridge. That protection could be accomplished through the placement of rock riprap or through techniques such as the planting of native vegetation which would protect and strengthen streambanks. The channel modification would terminate at the site of the existing drop structure in Madison Park.

According to the engineering staffs of the Cities of Milwaukee and Wauwatosa, there are no drainage easements along the reach of Grantosa Creek between W. Hampton Avenue and Madison Park. It would be necessary to obtain such easements prior to construction of the recommended channel modification. Since the property owners involved will benefit directly from the proposed project by the reduction of flood stages, it is assumed that easements will be provided at no cost to the implementing agencies.

The excavation proposed for the W. Hampton Avenue box culvert and the reach upstream and downstream of that culvert would eliminate overtopping of W. Hampton Avenue during a 100-year recurrence interval flood. It would also reduce 100-year recurrence interval flood stages in the 190-foot long reach downstream of W. Hampton Avenue by from 1.8 to 2.0 feet in comparison to existing channel conditions, further decreasing the potential for secondary basement flooding of the apartments in this reach.

The proposed detention basin would reduce the 100-year recurrence interval flood flow sufficiently so that W. Glendale Avenue would not be overtopped and overflow from the Creek would not pond near the intersection of N. 100th Street and W. Ruby Avenue. As under Alternative No. 1, the potential for ponding and flooding under 100-year recurrence interval flood conditions could be eliminated through the construction of a parallel relief sewer in W. Ruby Avenue, west of N. 100th Street, through the installation of a backwater gate in a storm sewer which conveys local runoff, and through the addition of storm inlet capacity in N. 100th Street. Those facilities are shown on Map 6.

Also as under Alternative No. 1, it is recommended that additional inlets be provided in N. 100th Street between W. Glendale and W. Ruby Avenues and at the sag in the grade of N. 100th Street, located about 100 feet north of the intersection of N. 100th Street and W. Sharon Lane.

Under this alternative, hydraulic conditions for the back yard storm sewers running to W. Ruby Avenue and W. Sharon Lane would be similar to those under Alternative No. 1. It is, therefore, recommended that automatic backwater gates be installed in the sewers near their junctions with the storm sewers in W. Ruby Avenue and W. Sharon Lane. Landscaping measures to raise the grade or provide an earthen berm around part of the house at 10033 W. Ruby Avenue might be substituted for installation of the backwater gates.









Flooding in the area east of the intersection of N. 100th Street and W. Grantosa Drive would be eliminated during a 100-year recurrence interval flood event under planned land use and proposed drainage and channel conditions. Minor localized ponding which could occur in W. Grantosa Drive east of its intersection with N. 100th Street would not be expected to cause secondary flooding due to sanitary sewer backup.

As under Alternative No. 1, no specific measures to alleviate secondary flooding in the vicinity of the intersection of W. Grantosa Drive and W. Fiebrantz Avenue are included in this alternative. It is recommended that the sanitary sewer system in that area be tested in order to locate potential sources of inflow and infiltration.

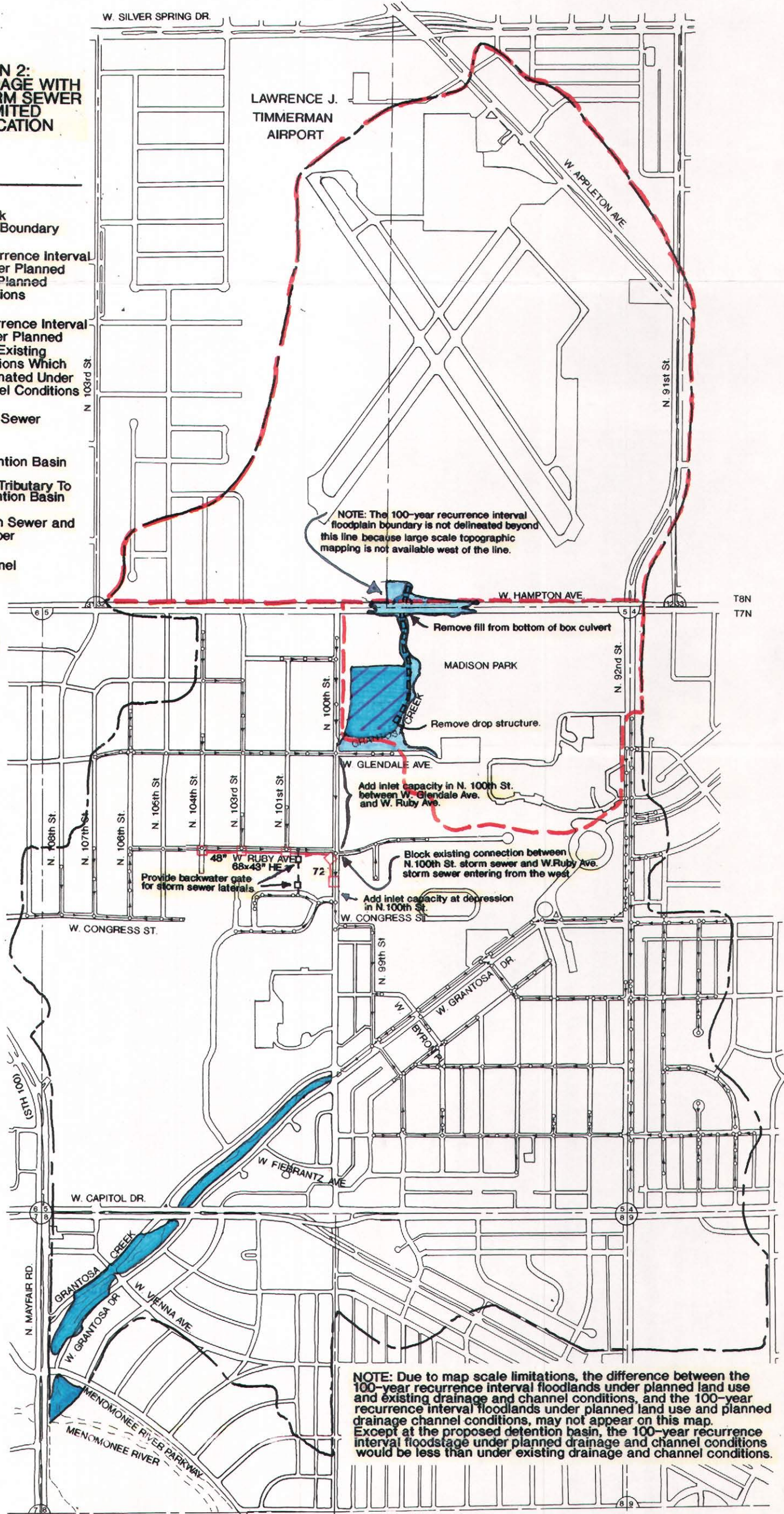
MAP 6

ALTERNATIVE PLAN 2: DETENTION STORAGE WITH ADDITIONAL STORM SEWER CAPACITY AND LIMITED CHANNEL MODIFICATION

LEGEND

-  Grantosa Creek Subwatershed Boundary
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Planned Channel Conditions
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Existing Channel Conditions Which Would Be Eliminated Under Planned Channel Conditions
-  Existing Storm Sewer and Manhole^a
-  Proposed Detention Basin
-  Drainage Area Tributary To Proposed Detention Basin
-  Proposed Storm Sewer and Junction Chamber
-  Proposed Channel Modification

^aOnly those existing storm sewers tributary to the Grantosa Creek channel enclosure are shown.



Utilizing an annual interest rate of 6 percent and a project life and amortization period of 50 years, the average annual cost of this alternative plan is estimated at \$99,200. This cost consists of the amortization of the \$1,448,000 capital cost and \$7,300 in annual operation and maintenance costs. The average annual flood damage abatement benefit is estimated at \$12,300, yielding a benefit-cost ratio of 0.12. The components of the operation and maintenance costs are the same as for Alternative No. 1.

ALTERNATIVE NO. 3--ADDITIONAL STORM SEWER CAPACITY WITH
EXISTING DETENTION STORAGE AND LIMITED CHANNEL MODIFICATION

As shown on Map 7, this alternative emphasizes the construction of additional conveyance components, while maintaining the existing detention storage within Madison Park.








As under Alternative No. 2, the 2.65 feet of backfill in the bottom of the W. Hampton Avenue box culvert would be removed and 0.24 mile of the Grantosa Creek channel would be lowered and widened to meet the lowered streambed elevation at W. Hampton Avenue. The modified channel would consist of a low-flow channel and a flood control channel with the same dimensions and alignment as proposed under Alternative No. 2. The measures proposed for the W. Hampton Avenue box culvert and the reach upstream and downstream of that culvert would eliminate overtopping of W. Hampton Avenue during a 100-year recurrence interval flood. They would also reduce 100-year recurrence interval flood stages in the 190-foot long reach downstream of W. Hampton Avenue from 1.4 to 1.7 feet in comparison to existing channel conditions, further decreasing the potential for secondary basement flooding of the apartments in this reach. The implementation of this alternative would require the procurement of drainage easements along the channel from W. Hampton Avenue to Madison Park. Since the property owners involved will benefit directly from the proposed project by the reduction of flood stages, it is assumed that easements will be provided at no cost to the implementing agencies.

The existing detention storage area, which is located in Madison Park to the north and west of the Grantosa Creek channel, would be retained. The existing channel enclosure, which begins in the park, would be supplemented with a

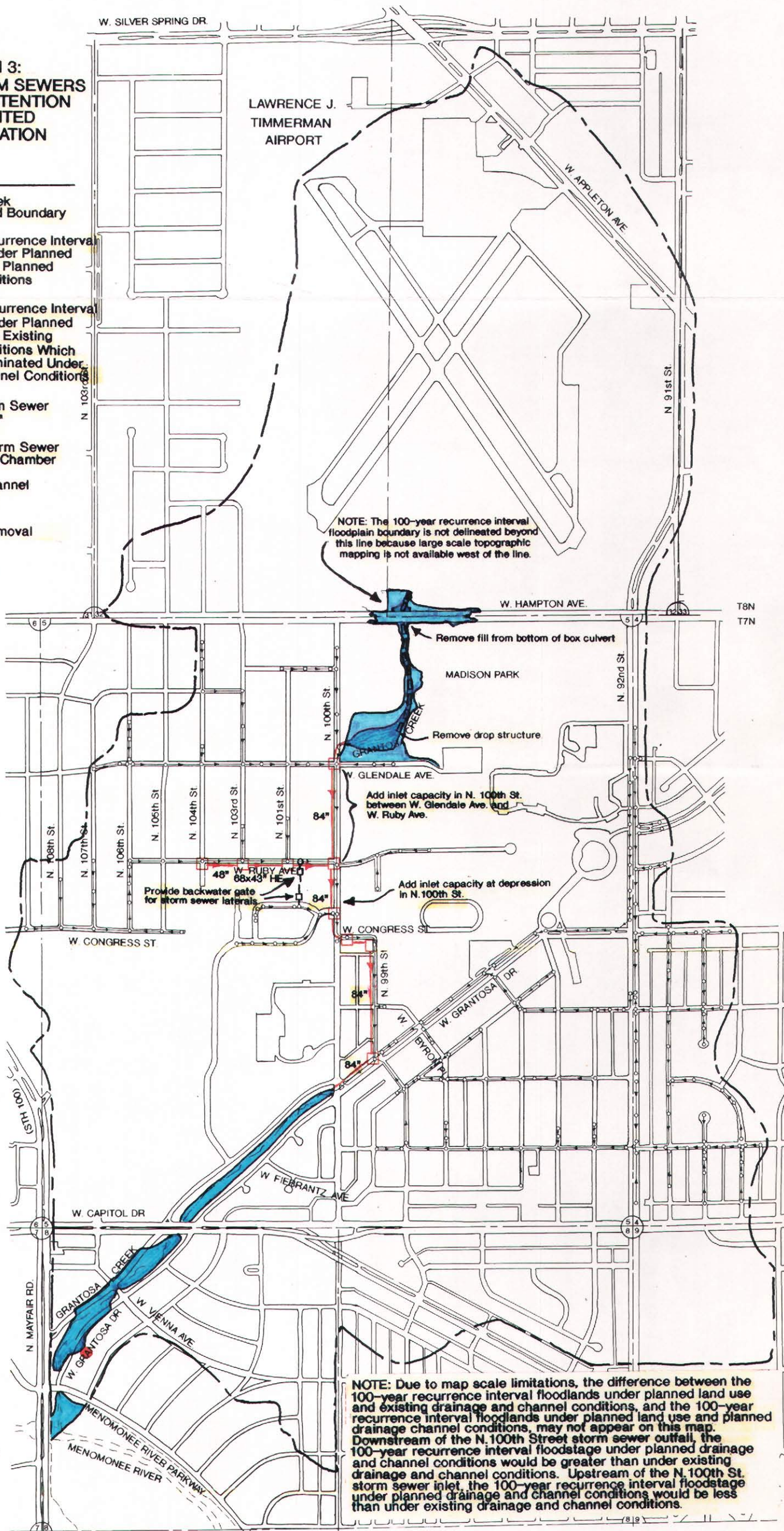
MAP 7

ALTERNATIVE PLAN 3: ADDITIONAL STORM SEWERS WITH EXISTING DETENTION STORAGE AND LIMITED CHANNEL MODIFICATION

LEGEND

-  Grantosa Creek Subwatershed Boundary
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Planned Channel Conditions
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Existing Channel Conditions Which Would Be Eliminated Under Planned Channel Conditions
-  Existing Storm Sewer and Manhole *
-  Proposed Storm Sewer and Junction Chamber
-  Proposed Channel Modification
-  Structure Removal

* Only those existing storm sewers tributary to the Grantosa Creek channel enclosure are shown.



3,720-foot long, parallel 84-inch diameter reinforced concrete relief storm sewer.

The proposed relief sewer would provide sufficient hydraulic capacity to convey the 100-year recurrence interval flood flow without overtopping W. Glendale Avenue; therefore, overflow from the Creek would not pond near the intersection of N. 100th Street and W. Ruby Avenue. The potential for ponding and flooding under 100-year recurrence interval flood conditions could be eliminated through the construction of a parallel relief sewer in W. Ruby Avenue, west of N. 100th Street; through the installation of a backwater gate in a storm sewer which conveys local runoff; and through the addition of storm inlet capacity in N. 100th Street. Those facilities are shown on Map 7. The 72-inch diameter storm sewer proposed under Alternatives No. 1 and 2 is not needed under this alternative because the hydraulic grade line in the existing and proposed 84-inch diameter storm sewers at the intersection of N. 100th Street and W. Ruby Avenue is low enough to enable the existing and proposed storm sewers in W. Ruby Avenue to convey the 100-year recurrence interval flood flow without backflow out manholes and inlets.

As under Alternatives No. 1 and 2, it is also recommended that additional inlets be provided in N. 100th Street between W. Glendale and W. Ruby Avenues and at the sag in the grade of N. 100th Street, which is located about 100 feet north of the intersection of N. 100th Street and W. Sharon Lane. Street.

Under this alternative, hydraulic conditions for the back yard storm sewers running to W. Ruby Avenue and W. Sharon Lane would be similar to those under Alternatives No. 1 and 2. It is, therefore, recommended that automatic backwater gates be installed in the sewers near their junctions with the storm sewers in W. Ruby Avenue and W. Sharon Lane. Landscaping measures to raise the grade or provide an earthen berm around part of the house at 10033 W. Ruby Avenue might be substituted for installation of the backwater gates.

Flooding in the area east of the intersection of N. 100th Street and W. Grantosa Drive would be eliminated during a 100-year recurrence interval flood event under planned land use and proposed drainage and channel conditions. Minor localized ponding which could occur in W. Grantosa Drive east of its

intersection with N. 100th Street would not be expected to cause secondary flooding due to sanitary sewer backup.

Because this alternative adds no detention storage to compensate for the removal of the existing storage in the streets and yards adjacent to N. 100th Street and W. Ruby Avenue, 100-year recurrence interval flood flows and stages would be increased in the 0.80-mile long reach from the outlet of the channel enclosure to the mouth of Grantosa Creek. The 100-year flood stages would increase from 0.05 to 0.34 feet above those under planned land use and existing channel conditions. Chapter NR 116 of the Wisconsin Administrative Code, which sets forth state regulations regarding floodplain management issues, requires that flooding easements or other appropriate legal arrangements be secured prior to the initiation of any activities within the floodplain which would create an increase in the 100-year recurrence interval flood stage of 0.01 foot or more. Much of the floodplain area affected by the increase in flood stages under this alternative is owned by Milwaukee County; however, it would be necessary to obtain legal agreements from about eleven private citizens, who own property within the 100-year recurrence interval floodplain, prior to initiation of this alternative.

Under this alternative, the 100-year flood stage increase at the house at 10711 W. Grantosa Drive would be sufficient to potentially cause shallow first floor flooding of the structure. Since the house has no basement, it would be possible to dry floodproof the structure to prevent flood damage. However, in a situation such as this where upstream flood control works increase flood stages enough to cause first floor flooding, the most prudent means of avoiding flood damage would be to purchase and remove the house. Therefore, purchase of the house and lot is proposed under this alternative.

As for Alternatives No. 1 and 2, no specific measures to alleviate secondary flooding in the vicinity of the intersection of W. Grantosa Drive and W. Fiebrantz Avenue are included in this alternative. It is recommended that the sanitary sewer system in that area be tested in order to locate potential sources of inflow and infiltration.

Utilizing an annual interest rate of 6 percent and a project life and amortization period of 50 years, the average annual cost of this alternative plan is

estimated at \$185,300. This cost consists of the amortization of the \$2,884,000 capital cost and \$2,200 in annual operation and maintenance costs. The average annual flood damage abatement benefit is estimated at \$12,300, yielding a benefit-cost ratio of 0.07.

ALTERNATIVE NO. 4--STRUCTURE FLOODPROOFING AND ELEVATION AND LIMITED CHANNEL MODIFICATION

A structure floodproofing and elevation system for flood control was analyzed to determine if such a structure-by-structure approach would be a technically feasible and economically viable solution to the flood problem. Floodproofing measures should be applied only under the guidance of a registered professional engineer who has carefully inspected the building and its contents, and has analyzed its structural integrity and evaluated the flood threat.

Floodproofing approaches may be classified as either "dry" or "wet". Dry floodproofing measures are intended to prevent the entry of floodwaters, thereby keeping a structure and its basement dry during floods. Dry floodproofing measures include the installation of backwater check valves in sanitary sewer building connections; the installation and operation of sump pumps to remove any floodwaters that enter the basement of a structure through foundation drains or other openings; the installation of waterproof seals at structural joints; the construction of earth berms or masonry or concrete floodwalls around a structure or a cluster of structures; and the installation of flood shields over doorways, windows, or other structure openings. Dry floodproofing measures which permit floodwaters to come in direct contact with a structure, or those which allow the soil around a basement to become saturated must be applied with extreme caution. Specific consideration must be given to the ability of the building walls and floor to withstand hydrostatic and uplift pressures.

Wet floodproofing measures would normally be applied to industrial buildings or to the basements of residential, commercial, or industrial buildings. Such measures would permit flooding of a portion of the building, such as the basement, in order to equalize the hydrostatic pressures on the basement walls and avoid collapse of the walls. Under this approach, all electrical wiring must be relocated at a level above the flood stage. Furnaces and water

heaters should either be relocated above flood stage, or protected with water-tight barriers. Provisions must also be made for shutting off gas service prior to flooding of the basement.

A system may be designed to intentionally flood a basement by permitting the entry of floodwaters before outside flood levels reach a height at which the walls would become unstable. Another approach would be to intentionally flood the basement with potable water to a level which adequately counteracts the hydrostatic pressure from the floodwaters. That approach reduces the cleanup expense by avoiding the accumulation in the basement of sediment and debris which would occur if floodwaters were permitted to enter the structure.

The 100-year recurrence interval flood stage under planned year 2010 land use and planned channel conditions was used to estimate the number of existing flood-prone structures which would be expected to be directly flooded. In addition, information obtained from the Cities of Milwaukee and Wauwatosa and from interviews with residents was used to locate buildings which have been subject to secondary flooding of basements.








As under Alternatives No. 2 and 3, the 2.65 feet of backfill in the bottom of the W. Hampton Avenue box culvert would be removed and 0.24 mile of the Grantos Creek channel would be lowered and widened to meet the lowered streambed elevation at W. Hampton Avenue. The modified channel would consist of a low-flow channel and a flood control channel with the same dimensions and alignment as proposed under Alternatives No. 2 and 3. The measures proposed for the W. Hampton Avenue box culvert and the reach upstream and downstream of that culvert would eliminate overtopping of W. Hampton Avenue during a 100-year recurrence interval flood. They would also reduce 100-year flood stages in the 190-foot long reach downstream of W. Hampton Avenue from 1.4 to 1.7 feet in comparison to existing channel conditions, further decreasing the potential for secondary basement flooding of the apartments in this reach. Since the property owners involved will benefit directly from the proposed project by the reduction of flood stages, it is assumed that the easements needed to modify the channel will be provided at no cost to the implementing agencies.

As shown on Map 8, a total of 21 single-family residences would be flood-proofed under this alternative. In addition, one single-family residence

MAP 8

ALTERNATIVE PLAN 4: STRUCTURE FLOODPROOFING AND ELEVATION AND LIMITED CHANNEL MODIFICATION

LEGEND

-  Grantosa Creek Subwatershed Boundary
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Planned Channel Conditions
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Existing Channel Conditions Which Would Be Eliminated Under Planned Channel Conditions
-  Existing Storm Sewer and Manhole *
-  Proposed Channel Modification
-  Structure Floodproofing
-  Structure Elevation

* Only those existing storm sewers tributary to the Grantosa Creek channel enclosure are shown.



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GRANTOSA CREEK STORMWATER DRAINAGE AND FLOOD CONTROL PLAN -
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would be elevated a total of 2.1 feet to a level two feet above the 100-year recurrence interval flood stage. The buildings to be floodproofed include all buildings listed in Table 1 and shown on Map 4 except the four apartments located on W. Hampton Avenue (buildings 1 through 4), the six single-family residences located on W. Fiebrantz Avenue (buildings 27 through 32), and the one single-family residence located at 10711 W. Grantosa Drive (building 33). The channel modification measures proposed under this alternative, along with floodproofing measures already installed, would be expected to substantially abate flood damages at the apartments during events with recurrence intervals up to and including 100 years. For reasons explained previously under Alternatives No. 1 through 3, no specific measures to alleviate secondary flooding at the residences located on W. Fiebrantz Avenue are included in this alternative. Finally, the residence at 10711 W. Grantosa Drive is excluded from floodproofing because no structure flooding or monetary flood damages would be expected during a 100-year flood.

Utilizing an annual interest rate of 6 percent and a project life and amortization period of 50 years, the average annual cost of this alternative plan is estimated at \$18,800. This cost consists of the amortization of the \$288,000 capital cost and \$500 in annual operation and maintenance costs. The average annual flood damage abatement benefits is estimated a \$12,300, yielding a benefit-cost ratio of 0.65.

Because of certain perceived disadvantages attendant to floodproofing, the floodproofing alternative was not considered to be directly comparable to the other alternatives. The disadvantages of a floodproofing approach in comparison to the other alternatives include, 1) the likelihood of incomplete implementation, which would leave a significant residual flood problem unless a public agency assumes responsibility for the costs and execution; 2) the possibility that in some instances major structural reinforcement or wet floodproofing may be required and the likelihood that either would be unacceptable to homeowners; and 3) the fact that a structure floodproofing approach would not alleviate street flooding in the vicinity of the intersections of N. 100th Street with W. Ruby Avenue, W. Congress Street, and W. Grantosa Drive. During a 100-year recurrence interval flood event, street flooding could occur to depths of up to about two feet, preventing vehicular access to, and egress from, houses along the flooded streets. In addition, because

the potential for secondary flooding has only been identified at those buildings for which such flooding has been documented in the files of the Cities of Milwaukee and Wauwatosa, or those buildings identified through interviews with residents of the area, there may be more buildings subject to secondary flooding than it is possible to identify based on available data. Secondary flooding of such buildings would be substantially abated under Alternatives No. 1, 2, and 3, but not under Alternative 4. Thus, although the estimated monetary cost of the floodproofing alternative is less than that of the other alternatives considered, a floodproofing approach was eliminated from further consideration due to its disadvantages when applied to the drainage and flooding problems along Grantosa Creek.

COMPARISON OF ALTERNATIVE PLANS

The alternative plans were compared with respect to cost, implementability, environmental impacts, aesthetic considerations, and impact on flood flows and stages along the Menomonee River. The costs of the alternative plans and a listing of the advantages and disadvantages of each plan are set forth in Table 3.

Costs

A review of Table 3 shows that Alternative No. 2, Detention Storage With Additional Storm Sewer Capacity and Limited Channel Modification, would have the lowest capital and total annual cost of the three alternatives which are still under consideration. The second least costly alternative would be Alternative No.1, Maximum Detention Storage and Additional Storm Sewer Capacity, followed by Alternative No. 3, Additional Storm Sewer Capacity With Existing Detention Storage and Limited Channel Modifications. The relative cost ranking of the alternatives is the same when total average annual costs of capital and operation and maintenance are compared; however, the difference between Alternative No. 3 and Alternatives No. 1 and 2 are less pronounced because of the relatively high annual operation and maintenance costs associated with the detention storage proposed under Alternatives No. 1 and 2.

The total capital cost of the most costly alternative, Alternative No. 3, is about 1.4 times the capital cost of Alternative No.1, and about two times the capital cost of Alternative No. 2.

It can be seen that under each alternative the costs of implementation exceeds the quantified benefits based upon the economic analyses conducted. However, other factors besides costs must be weighed in considering the alternatives, including importantly public health and safety considerations and the unwillingness of the public to be subjected to periodic flooding and poor drainage conditions.

Implementability

Alternative No. 1 would be constructed on public property or within current public rights-of-way, and would, therefore, be somewhat more easily implemented than Alternatives No. 2 and 3 which would require procurement of drainage easements along the 400-foot-long reach of Grantosa Creek between W. Hampton Avenue and Madison Park.

Environmental Impacts

The alternative plans were evaluated with respect to their potential impacts on terrestrial and aquatic habitat, streambank erosion and streambed scour, and water temperatures.

Under Commission surface water quality standards the recommended water use objective for the lower 0.80-mile long reach of Grantosa Creek would be for limited fish and aquatic life and limited recreational use. The corresponding Department of Natural Resources classification is limited aquatic life (marginal surface waters). The 0.35-mile long reach of the stream upstream of the enclosure is unclassified. The water use objectives established by the Commission for the reach of the Menomonee River downstream of its confluence with Grantosa Creek call for the maintenance of warmwater fish and aquatic life and recreational use. Those objectives correspond to a Department of Natural Resources category of warm water sport fish communities (FAL-B).

The water use objectives concerned indicate that the aquatic habitat possibilities of Grantosa Creek are limited. However, flood control measures undertaken along Grantosa Creek, if not properly designed, could also have some adverse impacts on the water quality and habitat characteristics of the Menomonee River, which has a higher water use objective classification.

None of the alternatives propose any modification to the lower reach of Grantosa Creek; therefore, the existing aquatic and terrestrial habitat conditions of that reach would not be degraded.

The detention basin proposed for Madison Park under Alternatives No. 1 and 2 would cause some disturbance to terrestrial habitat during construction, but following construction the habitat characteristics of the basin area could actually be improved over existing conditions through landscaping. Because the detention basins proposed under Alternatives No. 1 and 2 would not be designed to detain water for long periods of time, their impact on the temperature of downstream waters would be expected to be insignificant.

Because Alternative 3 relies more heavily on conveyance, rather than storage, of runoff, flood flows and flow velocities in the lower 0.8-mile long reach of Grantosa Creek would be somewhat greater under this alternative than under Alternatives 1 and 2, or under existing channel conditions. In most instances the increase in velocities would be slight; however, in areas of existing streambank erosion, some acceleration of the rate of erosion could occur if Alternative 3 were implemented without erosion control measures.

The natural low-flow channel provides the primary habitat for fish and aquatic organisms. The physical characteristics of the low-flow channel are determined by the more frequent floods with recurrence intervals up to 2 years. If the magnitude and frequency of lower flows are maintained at existing levels, the existing hydrologic and hydraulic regime of the stream will be maintained. Under existing land use, drainage and channel conditions, some streambank erosion has occurred along the Creek. By reducing the magnitude and frequency of lower flows in comparison to existing conditions, erosion and scour problems associated with the existing channel regime can be mitigated. The impacts of the alternative plans on a 2-year recurrence interval flood can be seen from Table 1. Of the three alternatives under consideration, Alternative 1 would provide the greatest reductions in 2-year flood flows. Under Alternative 2, 2-year flows would also be reduced in comparison with existing conditions, although not to the same degree as under Alternative 1. Under Alternative 3, 2-year flows are either increased or do not change in comparison with existing conditions. Thus, only Alternatives 1 and 2 would provide

some reduction in the peak flows during the more-frequent floods and an associated decrease in the existing rate of bank erosion.

Under Alternative 1, the existing low-flow stream channel would be maintained in the reach from the inlet of the existing channel enclosure to the source of the Creek at Timmerman Airport. Under Alternatives 2 and 3, the existing low-flow channel would be maintained from the enclosure inlet to the existing drop structure in Madison Park. Upstream of the drop structure, the channel would be modified. The modified channel would consist of a low-flow channel and a flood control channel. The riprap-lined low flow channel would be meandered so as to promote the formation of an alternating series of deep pools and shallow riffles, as would occur in a natural stream. Such pools and riffles would provide valuable habitat for aquatic life.

Aesthetic Considerations

Almost all of the open channel portions of Grantosa Creek flow through Milwaukee County park land. The stream has been modified and realigned at certain locations in the past; however, it is a valuable component of a landscaped urban parkway. Because the lower 0.80-long mile reach of the stream would not be directly modified under any of the alternatives considered, the aesthetic qualities of that reach of the stream would be preserved. Under Alternatives 1 and 2, the north and west overbank area along the reach of stream in Madison Park would be excavated and regraded for the construction of a detention basin. That area presently serves simply as open space use and the vegetation growth is not controlled. The natural character of that area could be enhanced through landscaping designed to complement the park setting and also to preserve any natural habitat which exists under existing conditions.

The aesthetic qualities of the reach of Grantosa Creek upstream of Madison Park have been degraded. That reach is adjacent to apartment complexes and W. Hampton Avenue, which functions as a major arterial street. The proximity to densely developed and high traffic areas and a lack of channel maintenance have contributed to the aesthetic degradation in the reach. The channel modification proposed under Alternatives 2 and 3 would provide an opportunity to restore this reach of stream. The channel alignment could be varied to produce a more aesthetic and natural-looking stream than under existing conditions. Erosion protection would be required on the channel banks in the reach

between W. Hampton Avenue and the pedestrian bridge. Such protection could be accomplished through the placement of rock riprap or through soil bioengineering techniques, which involve the use of native plant species to stabilize banks.

Impact on Flood Flows and Stages Along the Menomonee River

The hydrologic and hydraulic modeling performed for this study indicates that none of the alternatives would have a significant impact on flood flows and stages along the Menomonee River.

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Chapter III

RECOMMENDED STORMWATER DRAINAGE AND FLOOD CONTROL SYSTEM PLAN

SELECTION OF RECOMMENDED PLAN

Based on the evaluation of the costs, implementability, environmental impacts, and aesthetic considerations of the three alternative drainage and flood control plans under consideration, it is recommended that Alternative No. 2-- Detention Storage with Additional Storm Sewer Capacity and Limited Channel Modification be implemented. Full implementation of this plan would serve to eliminate structural flood damages along the open channel and enclosed reaches of Grantosa Creek for floods up to and including the 100-year recurrence interval flood under planned land use, drainage, and channel conditions. The recommended plan is shown in graphic form on Map 9. The 100-year recurrence interval flood profile for Grantosa Creek under planned land use, drainage, and channel conditions is shown on Figure 1. A plan view of the modified channel is shown on Figure 2. Typical channel cross sections are shown on Figure 3.

CONSIDERATION OF REFINEMENTS TO THE RECOMMENDED PLAN

Refinements Suggested by Milwaukee County Staff









In a letter of January 6, 1992, providing review comments on the preliminary draft of this report, Milwaukee County staff requested that consideration be given to a refinement of the recommended plan whereby the 23 acre-foot detention basin in Madison Park would be eliminated and a detention basin would be proposed on Timmerman Airport between the Timmerman storm sewer outfall and W. Hampton Avenue. That refinement was analyzed and it was found that a 23 acre-foot basin at Timmerman Airport would achieve the same degree of control of 100-year recurrence interval flood flows as under the recommended plan, assuming the existing storage volume in Madison Park is essentially maintained.

If a basin were constructed at the airport, it would still be necessary to modify the channel at, and downstream of, W. Hampton Avenue. If the channel

MAP 9

RECOMMENDED PLAN: DETENTION STORAGE WITH ADDITIONAL STORM SEWERS AND LIMITED CHANNEL MODIFICATION

LEGEND

-  Grantosa Creek Subwatershed Boundary
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Planned Channel Conditions
-  100-Year Recurrence Interval Floodplain Under Planned Land Use and Existing Channel Conditions Which Would Be Eliminated Under Planned Channel Conditions
-  Existing Storm Sewer and Manhole *
-  Proposed Detention Basin
-  Drainage Area Tributary To Proposed Detention Basin
-  Proposed Storm Sewer and Junction Chamber
-  Proposed Channel Modification

*Only those existing storm sewers tributary to the Grantosa Creek channel enclosure are shown.

Periodically remove sediment accumulation at the inlet and outlet of the Menomonee River Parkway double box culvert

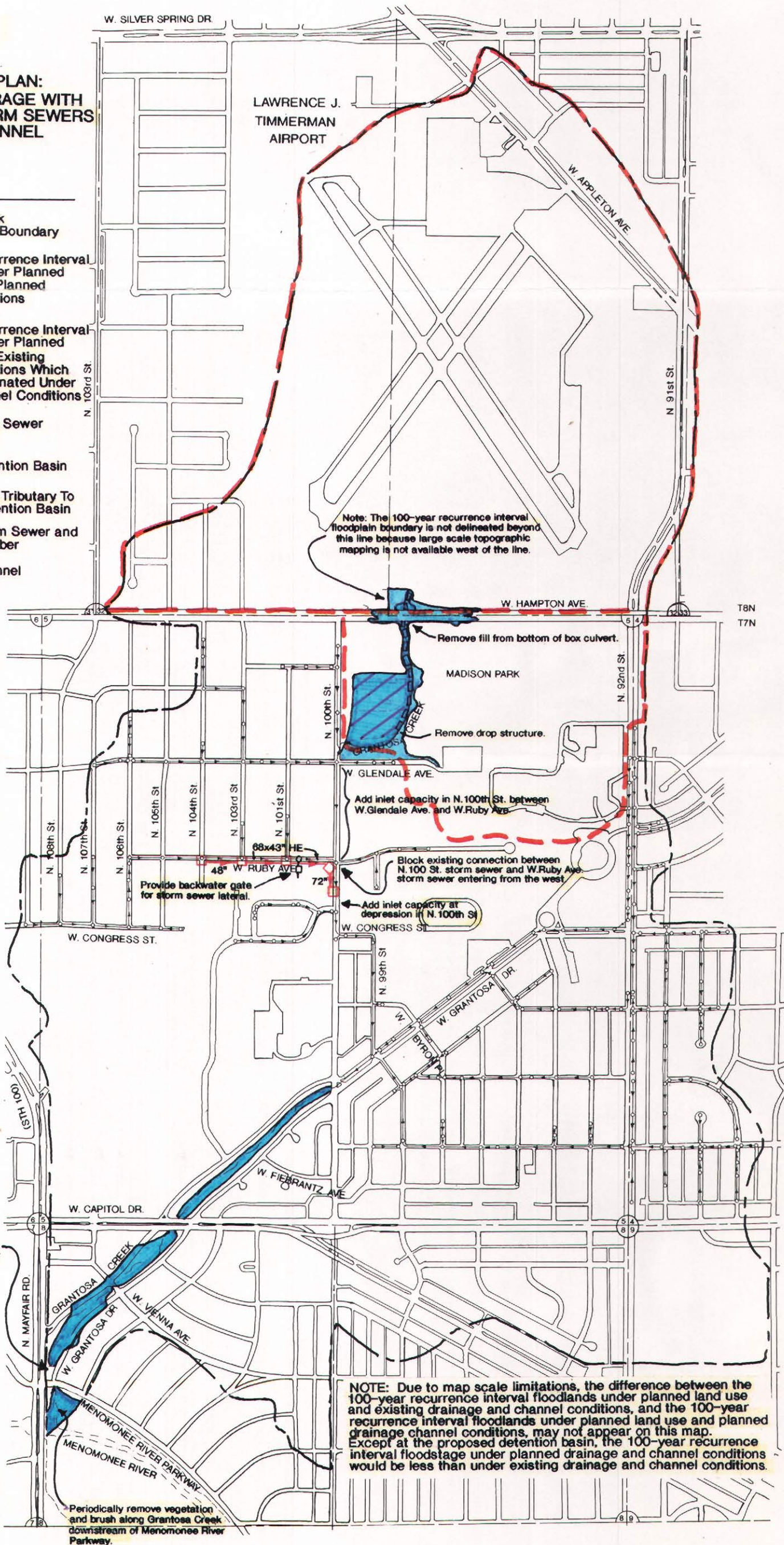
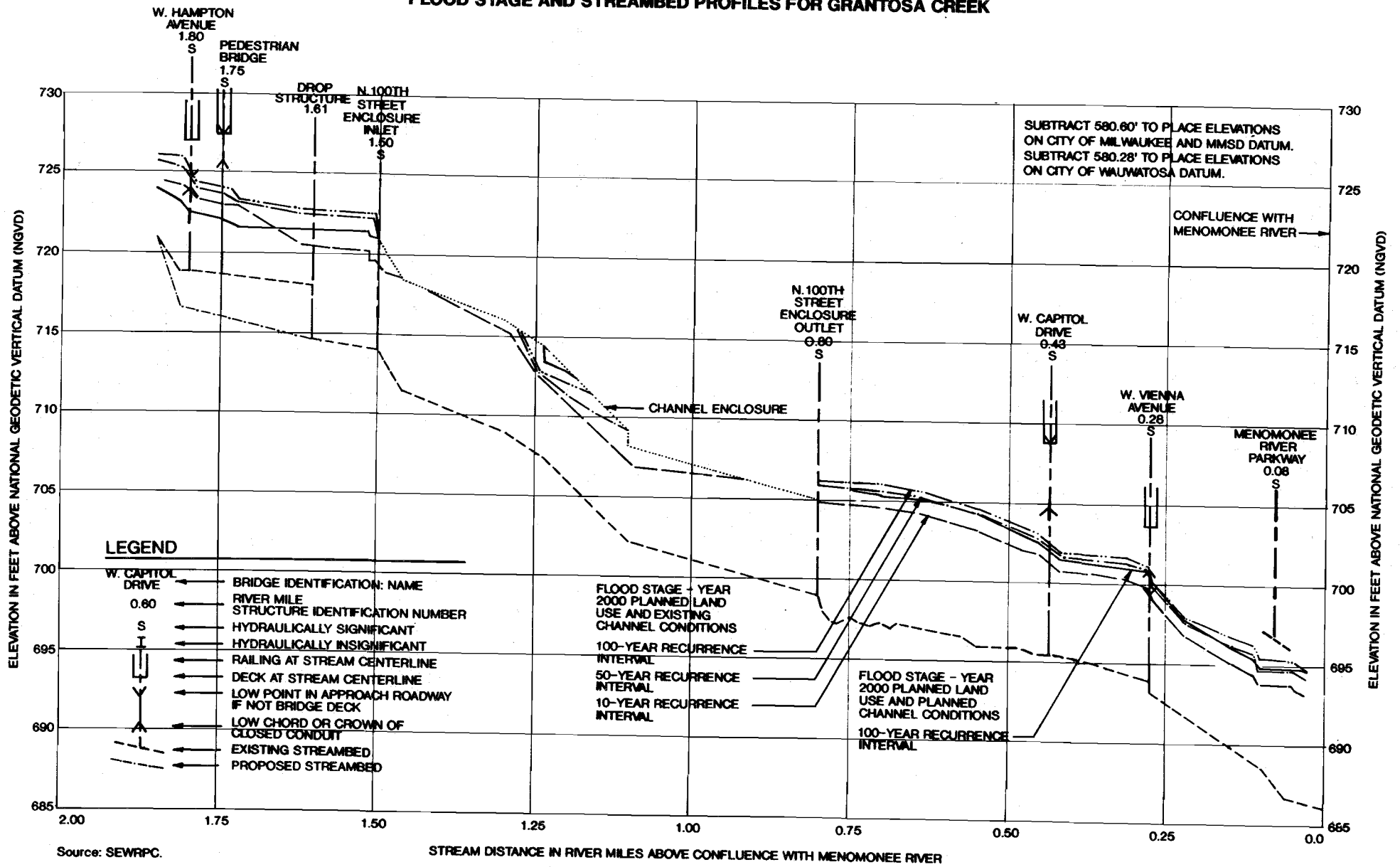


FIGURE 1

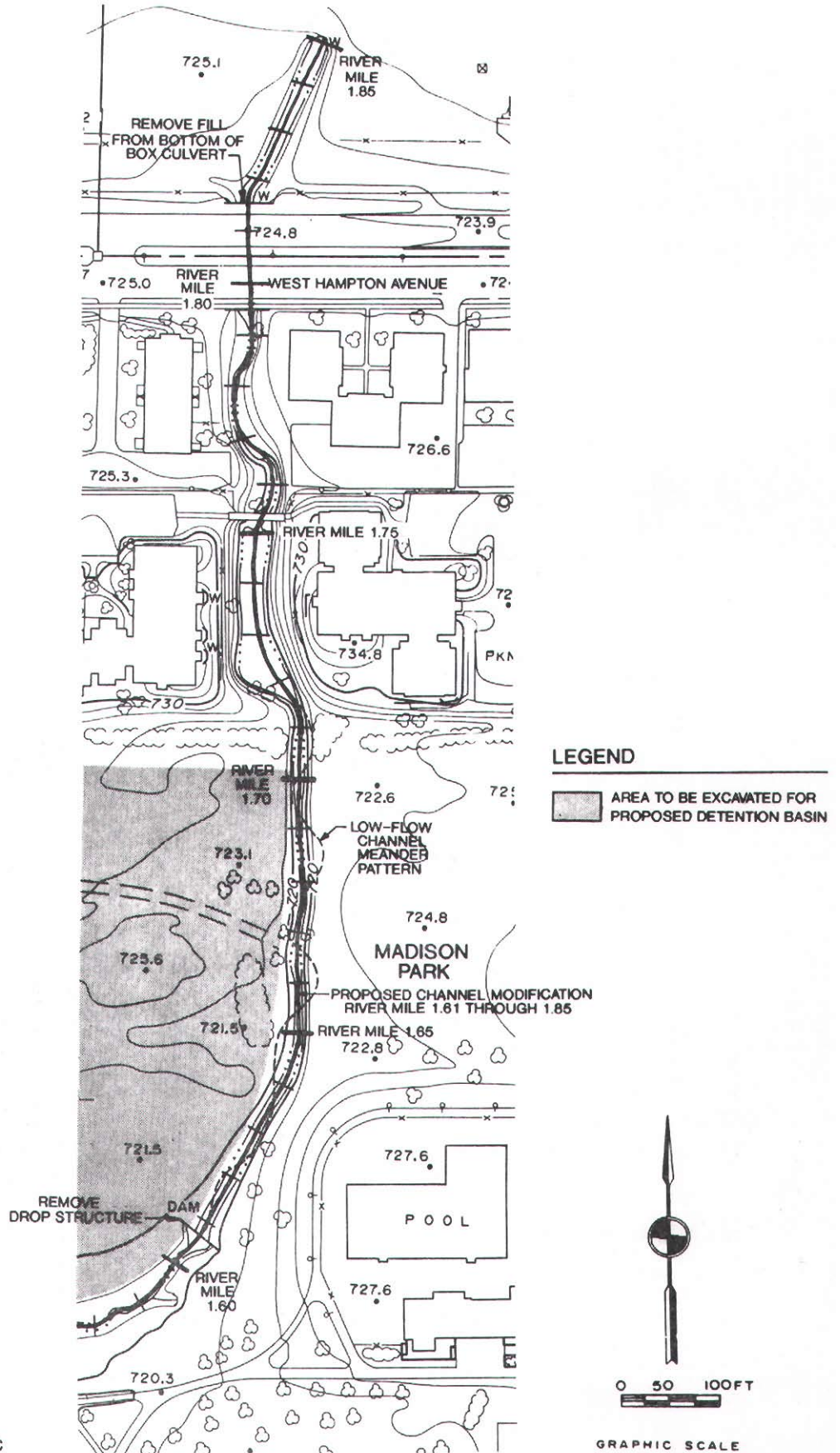
FLOOD STAGE AND STREAMBED PROFILES FOR GRANTOSA CREEK



Source: SEWRPC.

FIGURE 2

PLAN VIEW OF RECOMMENDED CHANNEL MODIFICATION



were not modified, approximately 32 acre-feet of storage volume would be required at the airport because the storage area outlet capacity would be less than with a modified channel. In addition to channel modification, alteration of the inlet to the W. Hampton Avenue box culvert would be required to obtain the relationship between storage volume and basin outflow needed to ensure proper performance of the basin.

The cost of the recommended plan would be approximately the same if detention storage were provided at either site. This is true because there would be no direct land acquisition costs associated with either site, both basin sites being located on County property; because the basin sizes would be comparable; and because some channel modification would be required with either basin site. Thus, at such time as the recommended plan is implemented, the option of locating the recommended detention storage at the airport could be selected if that site were preferable to the County

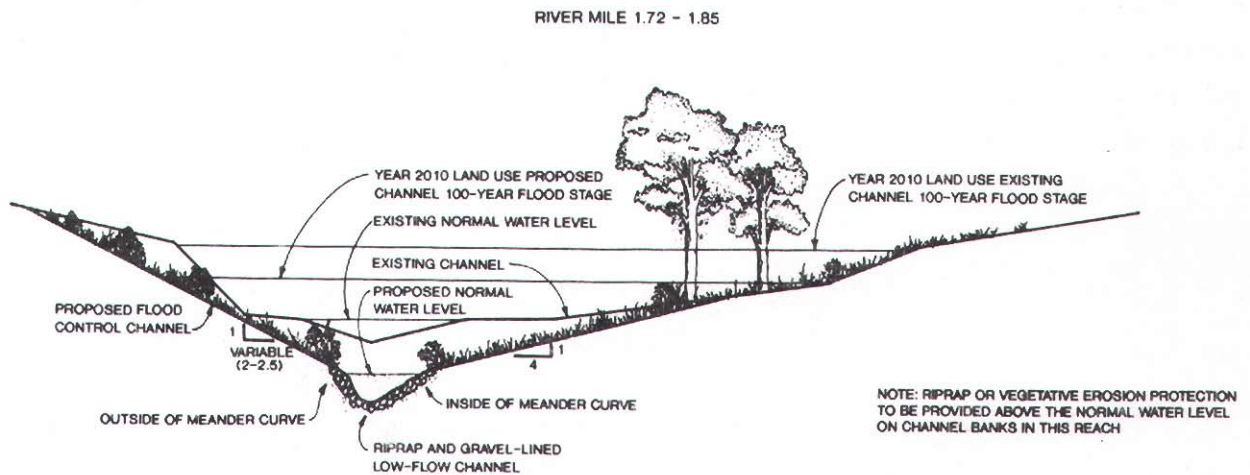
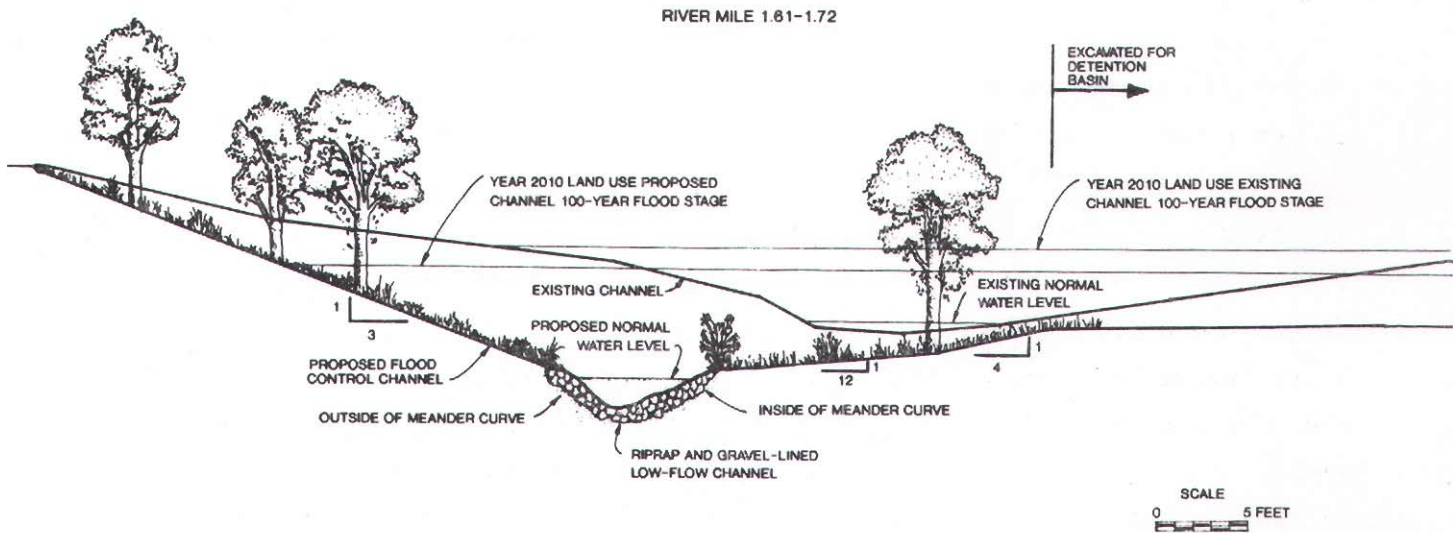
Possible Refinements Based on Comments by Area Residents

Mr. William G. Danielson of 10711 W. Grantosa Drive, between Menomonee River Parkway and W. Vienna Avenue, who has experienced direct flooding of his yard and garage; and Mr. Leslie Chell of 10046 W. Fiebrantz Avenue, who has experienced basement flooding due to sanitary sewer backup, are concerned citizens who live along or near Grantosa Creek.

Under planned land use conditions with existing drainage and channel conditions, no flooding of the Danielson residence would be expected during a 100-year recurrence interval flood. The peak water level during such a flood would be slightly lower than the peak level during the August 6, 1986 flood. On August 6, 1986, the front yard up to the house, the driveway, and part of the attached garage at the Danielson residence received shallow flooding to an elevation within about 2 inches of the elevation of the front door threshold. The house has no basement and no flood damage was reported. Under the recommended plan, the 100-year recurrence interval flood level at the Danielson residence would be reduced about 0.2 foot below the level under existing drainage and channel conditions. Thus, the recommended plan would reduce the flood hazard at the Danielson residence.

FIGURE 3

TYPICAL CROSS SECTIONS OF EXISTING AND PROPOSED
CHANNEL ALONG GRANTOSA CREEK FROM RIVER MILE 1.61 TO 1.85



Source: SEWRPC

Mr. Chell lives in the area where basement flooding problems have occurred due to sanitary sewer backup. In that area, it is recommended that the sanitary sewer system be studied by the City of Milwaukee to identify possible sources of clearwater infiltration and inflow which would cause sanitary sewer backup during floods, and that corrective measures be taken to avoid surcharging of the sanitary sewers in the area. Overbank flooding from Grantosa Creek does not appear to be the cause of the sanitary sewer backup, because, during floods with recurrence intervals up to and including 100 years, Grantosa Creek does not rise to a level which causes flooding of adjacent streets or sanitary sewers. Street flooding which occurs during such large floods is due to the accumulation of stormwater runoff which is conveyed to the Creek in the streets. Some improvement in the sanitary sewer backup problem might be realized from implementation of the recommended drainage and flood control measures because the storm drainage systems in the area of secondary flooding would function more efficiently with outlet submergence reduced due to lower flood flows and stages in Grantosa Creek.

Mr. Danielson and Mr. Chell have suggested that Milwaukee County and the Regional Planning Commission evaluate several specific measures for the alleviation of flooding problems along Grantosa Creek. Those measures include:

1. Excavation of the gravel bar which has formed along the north bank of the Menomonee River just downstream of its confluence with Grantosa Creek.
2. Periodic removal of vegetation along the banks of Grantosa Creek in the 310-foot long reach from Menomonee River Parkway to the Menomonee River.
3. Excavation of accumulated sediment at the inlet and outlet of the double box culvert under Menomonee River Parkway.
4. Realignment of the reach of Grantosa Creek downstream of Menomonee River Parkway in order to provide a more hydraulically-efficient transition for flow entering the Menomonee River from Grantosa Creek. Under existing conditions Grantosa Creek flows into the Menomonee River at a right angle.

5. The construction of low dikes at locations where the Creek might overflow its banks between Menomonee River Parkway and W. Capitol Drive.

The effects of implementation of the preceding measures were analyzed individually, and in combination, to determine the impacts of the measures on 100-year recurrence interval flood stages under planned land use, drainage, and channel conditions. The analysis of the measures was made within the context of the recommended stormwater drainage and flood control plan. All changes in 100-year recurrence interval flood stage cited below are referenced to the flood stage under planned land use and recommended drainage and channel conditions.

It was found that no combination of the suggested measures would have a significant impact on 100-year flood levels at, or upstream of, a section located 0.22 mile upstream of the mouth of Grantosa Creek, or about 320 feet downstream of W. Vienna Avenue. Therefore, the measures would have no significant impact in the vicinity of the Chell residence. The impacts on the Danielson residence are described below in the following sections.

Removal of the gravel bar in the Menomonee River may be expected to lower the River stage by 0.13 foot, but the decrease in the Grantosa Creek stage upstream of Menomonee River Parkway would be less than 0.10 foot. At the Danielson residence, the decrease in stage would be a maximum of 0.04 foot. Removal of vegetation and trees along the banks of Grantosa Creek from Menomonee River Parkway to the Menomonee River may be expected to reduce flood stages at the Danielson residence by a maximum of 0.22 foot. The combination of removal of the gravel bar and removal of vegetation would reduce flood stages at the Danielson residence by a maximum of 0.28 foot.

Excavation of accumulated sediment at the inlet and outlet of the Menomonee River Parkway double box culvert would lower the Grantosa Creek stage a maximum of 0.22 feet at the Danielson residence. The combination of removal of the sediment at the box culvert and removal of vegetation downstream of the culvert would reduce flood stages at the Danielson residence by a maximum of 0.50 foot. The combination of removal of the gravel bar in the Menomonee River, removal of vegetation downstream of Menomonee River Parkway, and

removal of sediment at the box culvert would reduce flood stages at the Danielson residence by a maximum of 0.55 foot.

Realignment of the reach of Grantosa Creek downstream of Menomonee River Parkway could provide a more hydraulically-efficient transition for flow entering the Menomonee River from Grantosa Creek; however, during large floods on the order of a 100-year recurrence interval event, a realigned Grantosa Creek channel would be submerged by the Menomonee River flood stage and the backwater effects of the Menomonee River on Grantosa Creek would be about the same as under existing Grantosa Creek channel conditions.

Construction of low dikes to protect Grantosa Drive and adjacent yards from flooding would block the overland flow paths for stormwater runoff to reach Grantosa Creek. Runoff would pond behind the dikes and could create a street and yard flooding situation similar to, or worse than, that without dikes. The elimination of street and yard flooding would require the provision of stormwater pumping facilities to convey the stormwater runoff from the landward side of the dikes to Grantosa Creek. Such pumping facilities would be expensive and their cost would not be justified to prevent limited street and yard flooding under extreme flood conditions.

Based on the preceding analysis of the effects of the measures set forth by Mr. Danielson and Mr. Chell, it may be concluded that a combination of vegetation removal downstream of Menomonee River Parkway and sediment removal at the inlet and outlet of the Menomonee River Parkway double box culvert would have the most significant impact on 100-year recurrence interval flood stages along Grantosa Creek in the first 0.22 mile upstream of its mouth. The additional reduction in flood stage due to removal of the gravel bar in the Menomonee River would not be significant enough to warrant such a measure. While the stage reductions would not be necessary to prevent flood damage to any buildings, they would provide an additional margin of safety against possible flooding at the Danielson residence and at neighboring residences on each side. That margin of safety would be desirable due to the past observation of inundation in contact with the Danielson house and to the fact that, in the past, debris has collected on the double box culvert during flood conditions, reducing its hydraulic capacity somewhat and raising upstream stages.

The impact of the combination of vegetation and sediment removal on street flooding was investigated to determine if such measures would significantly reduce the frequency of flooding of W. Grantosa Drive. Under the recommended drainage and flood control plan, flooding of W. Grantosa Drive due to overflow from Grantosa Creek would not be expected during floods up to, and including, a 25-year recurrence interval flood. However, Commission standards only recommend that a collector street, such as W. Grantosa Drive, be protected during floods with recurrence intervals up to, and including, 10 years. Implementation of the additional vegetation and sediment removal measures would prevent street flooding from overflow of the Creek during floods up to, and including, a 50-year recurrence interval flood.

Vegetation removal downstream of Menomonee River Parkway and sediment removal at the Menomonee River Parkway double box culvert are channel maintenance measures which are required to insure that the double box culvert functions as designed. The initial measures could be accomplished at relatively little cost and subsequent maintenance would be even less costly if performed at regular intervals. It is, therefore, recommended that the vegetation along Grantosa Creek between Menomonee River Parkway and the Menomonee River be selectively removed where negative environmental impacts can be avoided; that the sediment buildup at the inlet and outlet of the double box culvert under Menomonee River Parkway be removed; and that Milwaukee County perform regular maintenance to control vegetation and sediment in those locations. The initial cost of the vegetation and sediment removal is estimated to be \$5,000. It is also recommended that the County continue its program of periodic removal of brush and debris along the entire reach of channel which flows through County lands, and that the County monitor existing streambank erosion sites and repair them as necessary, through the application of techniques such as the planting of native vegetation which protect and strengthen streambanks, or through placement of riprap or gabions.

IMPLEMENTATION OF THE RECOMMENDED STORMWATER DRAINAGE AND FLOOD CONTROL SYSTEM PLAN

Based on the current situation, whereby Milwaukee County and the Cities of Milwaukee and Wauwatosa share jurisdiction for drainage and flood control programs along Grantosa Creek, it is recommended that the stormwater drainage

and flood control plan for Grantosa Creek be implemented expeditiously through the cooperative efforts of those cities and the County. More specifically, it is recommended that the County design and supervise the construction of the channel modifications recommended for the reach from the Timmerman Airport storm sewer outfall through the existing drop structure in Madison Park. It is recommended that the County maintain the 110-foot long W. Hampton Avenue (CTH EE) culverts, the 190-foot long reach of modified channel upstream from W. Hampton Avenue within Timmerman Airport, and the 1,000-foot long reach of modified channel extending from W. Hampton Avenue into Madison Park. In order to construct and maintain the 420-foot segment of the modified channel in the reach in the Cities of Milwaukee and Wauwatosa between W. Hampton Avenue and Madison Park, the County will need to obtain drainage easements from riparian property owners. It is also recommended that the County design, construct, and maintain the proposed detention basin in Madison Park. Finally, it is recommended that the County continue periodic maintenance, including brush clearing and debris removal, along the reaches of Grantosa Creek which flow through County lands; monitor existing streambank erosion sites and repair them as necessary; remove vegetation along the Grantosa Creek channel downstream of Menomonee River Parkway; and remove sediment at the inlet and outlet of the Menomonee River Parkway double box culvert.

It is recommended that the City of Milwaukee design, construct, and maintain the facilities necessary for the installation of a backwater gate on the existing storm sewer lateral which conveys runoff collected in back yards south of W. Ruby Avenue to the storm sewer in W. Sharon Lane. It is also recommended that the City of Milwaukee design, construct, and maintain the additional storm sewer inlets recommended to be installed in N. 100th Street north of its intersection with W. Congress Street. Finally, it is recommended that the City of Milwaukee test the sanitary sewer system in the vicinity of W. Grantosa Drive and W. Fiebrantz Avenue in order to locate potential sources of inflow and infiltration and that appropriate measures be taken to reduce or eliminate infiltration or inflow to the sanitary sewers.

It is recommended that the City of Wauwatosa design, construct, and maintain the proposed storm sewers in W. Ruby Avenue and N. 100th Street and the additional stormwater inlets in N. 100th Street between W. Glendale Avenue and W. Ruby Avenue. Finally, it is recommended that the City of Wauwatosa design,

construct, and maintain the facilities necessary for the installation of a backwater gate on the existing storm sewer lateral which conveys runoff collected in back yards south of W. Ruby Avenue to the storm sewer in W. Ruby Avenue.

A suggested apportionment of the capital costs of the recommended plan between Milwaukee County and the Cities of Milwaukee and Wauwatosa is given in Table 4. Channel modification costs are assigned based on the cost of the modification work within each of the cities, or on County lands. Storm sewer costs are assigned to the city in which the storm sewers are located. The remainder of the cost of the detention basin is divided equally between Milwaukee County and the Cities of Milwaukee and Wauwatosa. That division is made on the basis that runoff to the basin would come from County land and land in both cities, and that park improvement benefits would be realized by Milwaukee county and flood control benefits would be realized by the Cities of Milwaukee and Wauwatosa.

As shown in Table 4, if the Milwaukee Metropolitan Sewerage District were to assume jurisdiction for drainage and flood control along Grantosa Creek, the District would assume the costs for the design, construction, and maintenance of the recommended channel modification and the design and construction of the recommended detention storage facility.

Assuming classification by the Wisconsin Department of Natural Resources of the entire open channel portion of Grantosa Creek as a navigable stream, implementation of the recommended plan would require obtaining permits from the State of Wisconsin under Chapter 30 of the State statutes. The recommended placement of riprap would require a permit under Section 30.12, dealing with structures and deposits in navigable waters. That permit would be issued jointly by the State and the U.S. Army Corps of Engineers. The recommended channel modification would require excavation below the ordinary high water mark. Such excavation would require a State permit under Section 30.20, dealing with removal of material from beds of navigable waters. Activities in Milwaukee County are exempt from the requirements of Section 30.19, dealing with the enlargement of waterways. Also, Section 30.195 relating to the changing of stream courses would not be applicable to this project because no realignment of the stream is recommended.

Table 4

APPORTIONMENT OF CAPITAL COSTS FOR RECOMMENDED
GRANTOSA CREEK DRAINAGE AND FLOOD CONTROL PLAN

Implementing Agency	Flood Control Measure	Estimated Capital Cost if Grantosa Creek is not Placed Under the Jurisdiction of the MMSD ^a	Estimated Capital Cost if Grantosa Creek is Placed Under the Jurisdiction of the MMSD ^{a, b}
Milwaukee County	Channel Modification ^c Detention Basin	\$ 48,000 258,400	\$ 0
	Subtotal	\$ 306,400	\$ 0
City of Milwaukee	Channel Modification ^c Detention Basin	45,000 258,300	0 0
	Stormwater Inlets and Backwater Gate	10,000	10,000
	Subtotal	\$ 313,300	\$ 10,000
City of Wauwatosa	Channel Modification ^c Detention Basin	18,000 258,300	0 0
	Storm Sewers, Inlets, and Backwater Gate	552,000	552,000
	Subtotal	\$ 828,300	\$ 552,000
Milwaukee Metropolitan Sewerage District	Channel Modification ^c	0	111,000
	Detention Basin	0	775,000
	Subtotal	\$ 0	\$ 886,000
	Total	\$ 1,448,000	\$1,448,000

^aVegetation and sediment removal in the vicinity of Menomonee River Parkway, and brush and debris removal along reaches of the stream within County lands are considered as periodic maintenance costs, rather than capital costs, and are not included here.

^bCost apportioned based on SEWRPC Community Assistance Planning Report No. 130, A Stormwater Drainage and Flood Control Policy Plan for the Milwaukee Metropolitan Sewerage District, March 1986. The MMSD would also assume maintenance of the existing channel as set forth in footnote "a" and of the modified channel. Because of the multiple-use characteristics of the recommended detention basin, Milwaukee County would still be responsible for the estimated \$6,500 in annual basin maintenance costs.

^cSince the property owners from whom easements for channel modifications would be required will benefit directly from the proposed project by the reduction of flood stages, it is assumed that easements will be provided at no cost to the implementing agencies.

Source: SEWRPC

There are no wetlands identified on the State wetland inventory maps which would be affected by the recommended plan. Thus, the requirements of Chapter NR 103 of the Wisconsin Administrative Code, which sets forth rules regulating wetlands, would not apply to the plan.

No unusual difficulties should be entailed in obtaining the necessary permits required under Chapter 30. Because all permits would apply to the reach of Grantosa Creek located upstream of the existing 0.70-mile long channel enclosure, no significant impacts on fish and aquatic habitat would be expected. Good practice would dictate that special care be taken to control erosion during construction to minimize impacts on Grantosa Creek and the Menomonee River downstream of the enclosure.

If it were decided to add a permanent pond to the recommended detention basin, cost-sharing funds for basin construction may be available from the Wisconsin Department of Natural Resources under the Menomonee River Priority Watershed Program. As previously noted, a wet detention basin could pose safety hazards due to its location near Madison Elementary School and Timmerman Airport.