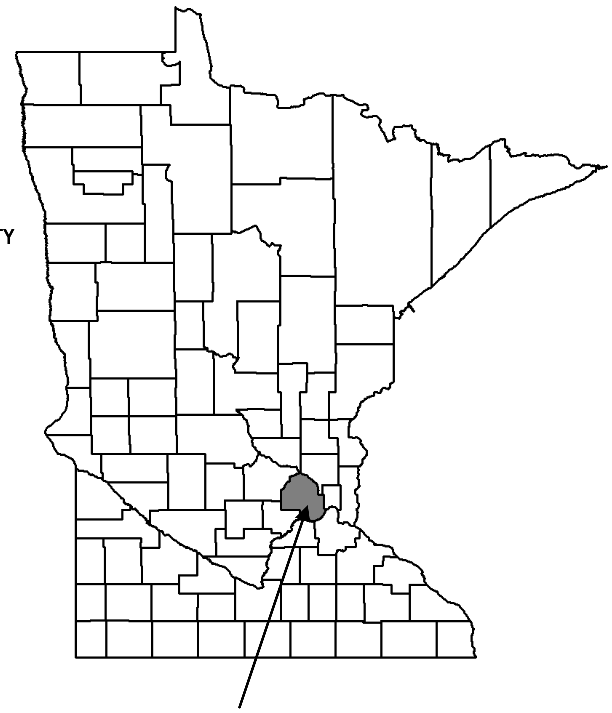
FLOOD INSURANCE STUDY

VOLUME 1 OF 2

HENNEPIN COUNTY, MINNESOTA (ALL JURISDICTIONS)



Hennepin County

COMMUNITY NAME	COMMUNITY NUMBER	COMMUNITY NAME	COMMUNITY NUMBER
BLOOMINGTON, CITY OF	275230	MEDINA, CITY OF	270171
BROOKLYN CENTER, CITY OF	270151	MINNEAPOLIS, CITY OF	270172
BROOKLYN PARK, CITY OF	270152	MINNETONKA, CITY OF	270173
CHAMPLIN, CITY OF	270153	MINNETONKA BEACH CITY OF, THE VILLAGE OF	270174
*CHANHASSEN, CITY OF	270051		
CORCORAN, CITY OF	270155	MINNETRISTA, CITY OF	270175
CRYSTAL, CITY OF	270156	MOUND, CITY OF	270176
DAYTON, CITY OF	270157	NEW HOPE, CITY OF	270177
DEEPHAVEN, CITY OF	270158	ORONO, CITY OF	270178
EDEN PRAIRIE, CITY OF	270159	*OSSEO, CITY OF	270658
EDINA, CITY OF	270160	PLYMOUTH, CITY OF	270179
EXCELSIOR, CITY OF	270161	RICHFIELD, CITY OF	270180
GOLDEN VALLEY, CITY OF	270162	ROBBINSDALE, CITY OF	270181
GREENFIELD, CITY OF	270673	ROCKFORD, CITY OF	270182
GREENWOOD, CITY OF	270164	ROGERS, CITY OF	270775
HANOVER, CITY OF	270540	SHOREWOOD, CITY OF	270185
HOPKINS, CITY OF	270166	SPRING PARK, CITY OF	270186
INDEPENDENCE, CITY OF	270167	*ST. ANTHONY, CITY OF	270716
LONG LAKE, CITY OF	270168	ST. BONIFACIUS, CITY OF	270183
LORETTO, CITY OF	270659	ST. LOUIS PARK, CITY OF	270184
MAPLE GROVE, CITY OF	270169	TONKA BAY, CITY OF	270187
MAPLE PLAIN, CITY OF	270170	WAYZATA, CITY OF	270188
MEDICINE LAKE, CITY OF	270690	WOODLAND, CITY OF	270189

*NO SPECIAL FLOOD HAZARD AREAS IDENTIFIED

Notice

This revised preliminary FIS report includes only revised Flood Profiles and Floodway Data tables. See "Notice to Flood Insurance Study Users" page for additional details.

Revised Preliminary:
August 17, 2012

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
27053CV001B

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study (FIS) may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

Part or all of this FIS may be revised and republished at any time. In addition, part of this FIS may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the FIS. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current FIS components.

Initial Countywide FIS Effective Date: September 2, 2004
Revised Countywide FIS Date: To Be Determined

This revised preliminary FIS report does not include unrevised Floodway Data Tables or unrevised Flood Profiles. These Floodway Data Tables and Flood Profiles will appear in the final FIS report.

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VOLUME 2 *(Continued)*

FLOOD INSURANCE STUDY
HENNEPIN COUNTY, MINNESOTA (ALL JURISDICTIONS)

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area for Hennepin County, Minnesota, including: the Cities of Bloomington, Brooklyn Center, Brooklyn Park, Champlin, Chanhassen, Corcoran, Crystal, Dayton, Deephaven, Eden Prairie, Edina, Excelsior, Golden Valley, Greenfield, Greenwood, Hanover, Hopkins, Independence, Long Lake, Loretto, Maple Grove, Maple Plain, Medicine Lake, Medina, Minneapolis, Minnetonka, The Village of Minnetonka Beach, Minnetrista, Mound, New Hope, Orono, Osseo, Plymouth, Richfield, Robbinsdale, Rockford, Shorewood, Spring Park, St. Anthony, St. Bonifacius, St. Louis Park, Tonka Bay, Wayzata, and Woodland (hereinafter referred to collectively as Hennepin County) and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

Please note that the incorporated jurisdiction of the Cities of Chanhassen, Dayton, Hanover, Rockford, and St. Anthony are not contained in their entirety within Hennepin County. They are located in other counties in addition to Hennepin County. It should be noted that the Cities of Dayton, Hanover, and Rockford have been shown in their entirety in the Hennepin County FIS (including the portions that lie within Wright County). In addition, the City of St. Anthony has been shown in its entirety in the Hennepin County FIS (including the portion that lies within Ramsey County). The City of Chanhassen lies predominantly in Carver County. Only the portions of the City of Chanhassen that lie within Hennepin County are shown in the Hennepin County FIS.

Please note that the Cities of Chanhassen, Osseo, and St. Anthony have no mapped special flood hazard areas.

Please also note that the Township of Hassan has been annexed by the City of Rogers.

This FIS has developed flood risk data that will be used to establish actuarial flood insurance rates. This information will also be used by Hennepin County to update existing floodplain regulations as part of the Regular Phase of the NFIP and local and regional planners to further promote sound land use and floodplain development. Minimum floodplain management requirements for participation in the NFIP are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence and the State (or other jurisdictional agency) will be able to explain them.

The Digital Flood Insurance Rate Map (DFIRM) and FIS Report for this countywide Study have been produced in digital format. Flood Hazard information was converted to meet the Federal Emergency Management Agency (FEMA) DFIRM database specifications and Geographic Information System (GIS) format requirements. The flood hazard information was created and is provided in a digital format so that it can be incorporated into a local GIS and be accessed more easily by the community.

1.2 Authority and Acknowledgments

The sources of authority for this FIS are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

Precountywide Analyses

This FIS was prepared to include the incorporated communities within Hennepin County into a countywide FIS. Information on the authority and acknowledgments for each jurisdiction included in this countywide FIS, as compiled from their previously printed FIS reports, is shown below.

Bloomington, City of:	The hydrologic and hydraulic analyses for the FIS report dated March 16, 1981, and the FIRM dated September 16, 1981, were performed by Edwards & Kelcey, Inc., for the Federal Insurance Administration (FIA), under Contract No. H-3983. The work was completed in June 1978 (FIA, 1981a).
Brooklyn Center, City of:	The hydrologic and hydraulic analyses for the FIS report dated August 17, 1981, and the FIRM dated February 17, 1982, were performed by the U.S. Geological Survey (USGS), Water Resources Division, Minnesota District, for the FIA, under Inter-Agency Agreements IAA-H-8-76, Project Order No. 10, and IAA-H-9-77, Project Order No. 37 (ext. 4-9-79). The work was completed in April 1980 (FIA, 1981b).

Brooklyn Park, City of:	The hydrologic and hydraulic analyses from the FIS report dated November 17, 1981, were prepared by the USGS, Water Resources Division, Minnesota District, for FEMA, under Inter-Agency Agreements IAA-H-17-75, Project Order No. 11; IAA-H-8-76, Project Order No. 1, Amendments 1-4; and IAA-H-9-77, Project Order No. 37 (ext. 4-9-79). That work was completed in April 1980. The revised analyses for the FIS report dated September 30, 1995, were prepared by the Brooklyn Park City Engineering Department. The work was completed in December 1993 (FEMA, 1995).
Champlin, City of:	The hydrologic and hydraulic analyses from the FIS report dated July 1977, were performed by the USGS, Water Resources Division, Minnesota District, for the FIA, under Inter-Agency Agreement No. IAA-H-17-75, Project Order No. 7. The work was completed in December 1975 (FIA, 1977a).
Corcoran, City of:	The hydrologic and hydraulic analyses for the FIS report dated July 16, 1980, and the FIRM dated January 16, 1981, were performed by Wehrman, Chapman Associates, Inc., for the FIA, under Contract No. H-4585. The work was completed in August 1978 (FIA, 1980c).
Crystal, City of:	The hydrologic and hydraulic analyses from the FIS report dated November 19, 1986, were performed by Barr Engineering Company, for FEMA, under Contract No. H-3799. The work was completed in October 1976 (FEMA, 1986c).
Dayton, City of:	The hydrologic and hydraulic analyses from the FIS report dated June 1, 1977, were performed by the USGS, Water Resources Division, St. Paul, Minnesota District, for the FIA, under Inter-Agency Agreement No. IAA-H-17-75, Project Order No. 8. The work was completed in September 1976. The revised analyses for the FIS report dated August 18, 1992, were performed by the U.S. Army Corps of Engineers (USACE), St. Paul District, under Inter-Agency Agreement No. EMW-89-E-2978, Project Order No. 5 (FEMA, 1992c).

Edina, City of:	The hydrologic and hydraulic analyses for the FIS report dated November 1979 and the FIRM dated May 1, 1980, were performed by the USGS, for the FIA, under Inter-Agency Agreement No. IAA-H-17-75, Project Order No. 10. The work was completed in April 1978 (FIA, 1979).
Golden Valley, City of:	The hydrologic and hydraulic analyses for the FIS report dated February 4, 1981, were performed by Edwards & Kelcey, Inc., for the FIA, under Contract No. H-3983. The work was completed in June 1979. The revised analyses for the FIS report dated August 19, 1986, were obtained from the Minnesota Department of Natural Resources (MDNR) (FEMA, 1986b).
Greenfield, City of:	The hydrologic and hydraulic analyses for the FIS report dated August 18, 1992, were performed by the USACE, St. Paul District, for FEMA, under Inter-Agency Agreement No. EMW-89-E-2978, Project Order No. 5. The work was completed in October 1990 (FEMA, 1992d).
Hanover, City of:	The hydrologic and hydraulic analyses for the FIS report dated August 3, 1992, were performed by the USACE, St. Paul District, for FEMA, under Inter-Agency Agreement No. EMW-89-E-2978, Project Order No. 5. The work was completed in June 1990 (FEMA, 1992b).
Rogers, City of (formerly Hassan, Township of):	The hydrologic and hydraulic analyses for the FIS report dated June 16, 1993, were performed by the USACE, St. Paul District, for FEMA, under Inter-Agency Agreement No. EMW-89-E-2978, Project Order No. 5. The work was completed in June 1990 (FEMA, 1993).
Hopkins, City of:	The hydrologic and hydraulic analyses for the FIS report dated November 5, 1980, were performed by Edwards & Kelcey, for the FIA, under Contract No. H-3983. The work was completed in September 1979. The revised analyses for the FIS report dated June 16, 1992, were performed by the USACE, St. Paul District, under Inter-Agency Agreement No. EMW-89-E-2994, Project Order No. 4 (FEMA, 1992a).

Independence, City of:	The hydrologic and hydraulic analyses for the FIS report dated July 6, 1982, were performed by Edwards & Kelcey, Inc., for FEMA, under Contract No. EMW-C-0322. The work was completed in September 1980. The revised analyses for the FIS report dated September 30, 1992, were performed by the USACE, St. Paul District, under Inter-Agency Agreement No. EMW-89-E-2978, Project Order No. 5 (FEMA, 1992g).
Maple Grove, City of:	The hydrologic and hydraulic analyses for the FIS report dated October 1977 and FIRM dated April 17, 1978, were performed by Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in September 1976 (FIA, 1977c).
Medicine Lake, City of:	The hydrologic and hydraulic analyses for the FIS report dated October 15, 1981, and FIRM dated April 15, 1982, were performed by Edwards & Kelcey, Inc., for FEMA, under Contract No. EMW-C-0322. The work was completed in September 1980 (FEMA, 1981c).
Medina, City of:	The hydrologic and hydraulic analyses for the FIS report dated March 1980 and FIRM dated September 3, 1980, were performed by Wehrman, Chapman Associates, for the FIA, under Contract No. H-4585. The work was completed in August 1978 (FIA, 1980a).
Minneapolis, City of:	The hydrologic and hydraulic analyses for the FIS report dated August 18, 1980, and FIRM dated February 18, 1981, were performed by the USGS, Water Resources Division, for the FIA, under Inter-Agency Agreement No. IAA-H8-76, Project Order No. 2, Amendment No. 1, and Inter-Agency Agreement No. IAA-H-9-77, Project Order No. 30 (extension). The work was completed in February 1979 (FEMA, 1980d).
Minnetonka, City of:	The hydrologic and hydraulic analyses for the FIS report dated November 19, 1980, were performed by Edwards & Kelcey, Inc., for the FIA, under Contract No. H-3983. The work was completed in September 1979. The revised analyses for the FIS report dated September 30, 1992, were performed by the USACE, St. Paul District, under Inter-Agency Agreement No. EMW-89-E2994, Project Order No. 4 (FEMA, 1992h).

Mound, City of: The hydrologic and hydraulic analyses for the FIS report dated March 1978 and FIRM dated September 29, 1978 were performed by Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in May 1977 (FIA, 1978b).

New Hope, City of: The hydrologic and hydraulic analyses for the FIS report dated July 1980 and the FIRM dated January 2, 1981, were performed by Edwards & Kelcey, Inc., for the FIA, under Contract No. H-3983. The work was completed in May 1979 (FIA, 1980b).

Orono, City of: The hydrologic and hydraulic analyses for the FIS report dated April 1978 and the FIRM dated October 17, 1978, were performed by Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in May 1977 (FIA, 1978c).

Plymouth, City of: The hydrologic and hydraulic analyses for the FIS report dated November 1977 and the FIRM dated February 19, 1982, were performed by the Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in April 1977 (FIA, 1977d).

Robbinsdale, City of: The hydrologic and hydraulic analyses for the FIS report dated August 1977 and the FIRM dated August 1, 1977, were performed by Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in September 1976 (FIA, 1977b).

Rockford, City of: The hydrologic and hydraulic analyses for the FIS report dated August 18, 1992, were performed by the USACE, St. Paul District, for FEMA, under Inter-Agency Agreement No. EMW-89-E-2978, Project Order No. 5. The work was completed in October 1990 (FEMA, 1992e).

Shorewood, City of: The hydrologic and hydraulic analyses for the FIS report dated June 1979 and the FIRM dated July 2, 1982, were performed by Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in November 1977 (FIA, 1979c).

Spring Park, City of:	The hydrologic and hydraulic analyses for the FIS report dated November 1978 and the FIRM dated May 1, 1979, were performed by Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in September 1977 (FIA, 1978e).
St. Louis Park, City of:	The hydrologic and hydraulic analyses for the FIS report dated June 1, 1977, were performed by the USGS, under Inter-Agency Agreement Nos. IAA-H-20-74 and IAA-H-17-75, Project Order Nos. 16 and 1, respectively. The work was completed in November 1974. The revised analyses for the FIS report dated June 17, 1986, were performed by the MDNR (FEMA, 1986a).
Tonka Bay, City of:	The hydrologic and hydraulic analyses for the FIS report dated November 1978 and the FIRM dated May 1, 1979, were performed by Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in October 1977 (FIA, 1978f).
Wayzata, City of:	The hydrologic and hydraulic analyses for the FIS report dated May 1979 and the FIRM dated June 11, 1982, were performed by Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in November 1977 (FIA, 1979b).
Woodland, City of:	The hydrologic and hydraulic analyses for the FIS report dated February 1979 and the FIRM dated January 6, 1982, were performed by Barr Engineering Company, for the FIA, under Contract No. H-3799. The work was completed in September 1977 (FIA, 1979a).

The Cities of Chanhassen, Deephaven, Eden Prairie, Excelsior, Greenwood, Long Lake, Loretto, Maple Plain, The Village of Minnetonka Beach, Minnetrista, Osseo, Richfield, St. Anthony, and St. Bonifacius have no previously printed FIS reports.

September 2, 2004
Initial Countywide FIS Report

For the September 2, 2004 initial countywide FIS, revised hydrologic and hydraulic analyses were prepared by the USACE, St. Paul District, for FEMA, under Inter-Agency Agreement No. EMW-95-E-4756 (PO 7) and EMW-97-IA-0140 (PO 11). The work was completed on August 19, 2000 (FEMA, 2004).

This Countywide FIS Report

New analyses were provided for this revised countywide study on the Minnesota River, the Nine Mile Creek Watershed, Minnehaha Creek Watershed, and Crow Creek.

The information for the Minnesota River was provided by the USACE. This 2004 study area extended approximately 36 river miles from the confluence with the Mississippi River to approximately 4 miles upstream of the Carver County boundary. The results were mapped using updated topography.

The Crow River was also revised to map areas where a floodplain was previously not shown due to political boundary changes. These areas were mapped using updated topography.

The Nine Mile Creek Watershed was modeled using the United States Environmental Protection Agency's Storm Water Management Model (SWMM), with a computerized graphical interface provided by XP Software (XP-SWMM). Barr Engineering Company (Minneapolis, Minnesota) did the computer-modeling for the Nine Mile Creek watershed. XP-SWMM uses rainfall and watershed information to generate runoff that is simultaneously routed through complicated pipe, channel, and overland flow networks. Atkins modified the hydraulic models with updated structure data. The work was completed in May 2012.

The Minnehaha Creek watershed was also modeled using XP-SWMM by Emmons & Olivier Resources, Inc. (Oakdale, Minnesota). In 2003 the Minnehaha Creek Watershed District (MCWD) completed the creation of a comprehensive hydrologic/hydraulic model for the entire watershed in Hennepin County and Carver County, Minnesota. The completion of the model allowed the MCWD to assess the impacts of proposed projects, both public and private, within the watershed. Atkins modified the hydraulic models with updated survey data and incorporated the results into the FIRMs. The work was completed in May 2012.

This countywide FIS was prepared by the Strategic Alliance for Risk Reduction (STARR), for FEMA, under Contract No. HSFEHQ-09-D-0370, Task Order No. HSFE05-10-J-0005. The work was completed in June 2012.

Base map information shown on this FIRM was provided in digital format by the MDNR. This information was photogrammetrically compiled at a scale of 1:12,000 from aerial photography dated 2010.

The projection system and horizontal datum used for the production of the FIRM is Universal Transverse Mercator (UTM) Zone 15, North American Datum of 1983 (NAD 83) Geodetic Reference System 1980 spheroid.

1.3 Coordination

Consultation Coordination Officer's (CCO) meetings may be held for each jurisdiction in this countywide FIS. An initial CCO meeting is held typically with representatives of FEMA, the community, the state, and the study contractor to explain the nature and purpose of a FIS, and to identify the streams to be studied by detailed methods. A final CCO meeting is held typically with representatives of FEMA, the community, and the study contractor to review the results of the study.

Precountywide Analyses

The dates of the initial and final CCO meetings held for previous FIS reports for Hennepin County and the incorporated communities within its boundaries are presented in Table 1. Note that there are no data available for the Cities of Chanhassen, Deephaven, Eden Prairie, Excelsior, Greenwood, Long Lake, Loreto, Maple Plain, The Village of Minnetonka Beach, Minnetrista, and St. Anthony.

Table 1 – Initial and Final CCO Meetings

Community	Initial CCO Date	Final CCO Date
Bloomington, City of	March 2, 1976	September 17, 1980
Brooklyn Center, City of	November 18, 1975	March 24, 1981
Brooklyn Park, City of	December 1974	March 23, 1981
Champlin, City of	October 10, 1974	March 9, 1976
Corcoran, City of	June 7, 1977	August 14, 1979
Crystal, City of	*	December 8, 1976
Dayton, City of	*	December 20, 1976
Edina, City of	November and December 1974	February 14, 1979
Golden Valley, City of	March 9, 1976	January 10, 1980
Greenfield, City of	June 27, 1988	August 28, 1991
Hanover, City of	June 27, 1988	August 28, 1991
Rogers, City of (formerly Hassan, Township of)	June 27, 1988	May 2, 1990
Hopkins, City of	March 12, 1976	March 27, 1980
Independence, City of	June 1979	January 26, 1982
Maple Grove, City of	July 30, 1975	November 17, 1976
Medicine Lake, City of	June 1979	April 22, 1981
Medina, City of	June 7, 1977	August 13, 1979
Minneapolis, City of	May 15, 1975	January 29, 1980
Minnetonka, City of	March 9, 1976	April 22, 1980
Mound, City of	February 1975	September 26, 1977
New Hope, City of	March 8, 1976	October 25, 1979
Orono, City of	February 1975	September 26, 1977
Plymouth, City of	*	November 30, 1976
Robbinsdale, City of	*	May 13, 1976
Rockford, City of	June 27, 1988	August 28, 1991

*Data not available

Table 1 – Initial and Final CCO Meetings *(continued)*

Community	Initial CCO Date	Final CCO Date
Shorewood, City of	July 1977	August 22, 1978
Spring Park, City of	July 1977	May 22, 1978
St. Louis Park, City of	*	June 16, 1976
Tonka Bay, City of	July 1977	May 23, 1978
Wayzata, City of	July 1977	October 25, 1978
Woodland, City of	July 1977	August 22, 1978

*Data not available

September 2, 2004
Initial Countywide FIS Report

For the September 2, 2004 initial countywide FIS, the final CCO meetings were held March 11 and 12, 2003. These meetings were attended by representatives of the region; USACE; the Cities of Champlin, Dayton, Eden Prairie, Golden Valley, Maple Grove, Minneapolis, Robbinsdale, and St. Louis Park; the State of Minnesota; and FEMA.

This Countywide FIS Report

For the revised countywide FIS, the final CCO meeting was held **_____________**. This meeting was attended by representatives of the region; USACE; the following communities: **___________**, ___, and **_______**; the MDNR; and FEMA.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS covers the geographic area of Hennepin County, Minnesota.

All or portions of the flooding sources presented in Table 2 were studied by detailed methods. Limits of detailed study are indicated on the Flood Profiles (Exhibit 1) and on the FIRM (Exhibit 2).

Table 2 – Flooding Sources Studied by Detailed Methods

Riverine Flooding Sources

Bass Creek	East Channel Mississippi River
Bassett Creek	Elm Creek
Bassett Creek – Sweeney Lake Branch	Gleason Creek
Braemer Branch	Lake Robina Tributary
Braemer Branch (Split Flow)	Long Lake Creek
Century Channel	Minnehaha Creek
Crow River	Minnesota River
Eagle Creek	Mississippi River
East Channel Bassett Creek	Nine Mile Creek (County Ditch 34)

Table 2 – Flooding Sources Studied by Detailed Methods *(continued)*

Riverine Flooding Sources *(continued)*

Nine Mile Creek (Main Stem)	Purgatory Creek
Nine Mile Creek (North Branch)	Rush Creek
Nine Mile Creek (South Branch)	Shingle Creek
North Branch Bassett Creek	Six Mile Creek
North Fork Rush Creek	South Fork Crow River
Painter Creek	Unnamed Tributary
Pioneer Creek	Unnamed Tributary to Stubbs Bay
Plymouth Creek	

Lacustrine Flooding Sources

Brownwood Pond	Lake Cornelia
Bush Lake	Lake Edina
Century Channel Ponds 1-22	Lake Hiawatha
Crystal Bay	Lake Independence
Dutch Lake	Lake Minnetonka (including numerous Feeder bays and lakes)
Eagle Lake	Lake Nokomis
Edinbrook Channel Ponds 15-53 and 76	Lake Robina
Edinbrook Chann	Lake Sarah
Fish Lake	Langdon Lake
Gaulke Pond	Medicine Lake
Grimes Avenue Pond	Memory Lane Pond
Hadley Lake	Pike Lake
Hagermeister Pond	Ponds A, B, C, D, E, F, G, and H
Halstead Bay	Pond downstream of Hadley Lake
Jennings Bay	Rice Lake
Lafayette Bay	Rice Lake (near Bassett Creek)
Lake Ardmore	Twin Lakes and Ryan Lake

September 2, 2004
Initial Countywide FIS Report

As part of the September 2, 2004, initial countywide FIS, updated analyses were included for the flooding sources presented in Table 3.

Table 3 – Scope of Revision (Initial Countywide FIS Report)

Flooding Source	Limits of Revised or New Detailed Study
Bassett Creek	From approximately 1, 500 feet downstream of Irving Avenue to Medicine Lake
Century Pond	Entire shoreline with Hennepin County
Crystal Bay	Entire shoreline with Hennepin County

Table 3 – Scope of Revision (Initial Countywide FIS Report) *(continued)*

Flooding Source	Limits of Revised or New Detailed Study
Dutch Lake	Entire shoreline with Hennepin County
East Channel Bassett Creek	From its confluence with Bassett Creek to just upstream of Floyd B. Olson Memorial Highway
Gleason Creek	From approximately 450 feet downstream of the confluence with Gleason Lake to approximately 175 feet downstream of the confluence with Gleason Lake
Halstead Bay	Entire shoreline with Hennepin County
Jennings Bay	Entire shoreline with Hennepin County
Lafayette Bay	Entire shoreline with Hennepin County
Lake Minnetonka	Entire shoreline with Hennepin County
Lake Sarah	Entire shoreline with Hennepin County
Mississippi River	From the downstream Ramsey corporate limits to the Lock and Dam No. 1.
North Branch Bassett Creek	From its confluence with Bassett Creek to approximately 1,175 feet upstream of Hampshire Avenue
North Fork Rush Creek	From approximately 400 feet upstream of the downstream 109^{th} Avenue North crossing to approximately 75 feet downstream of the upstream 109^{th} Avenue North crossing
Pioneer Creek	From approximately 0.6 miles upstream of County Highway 90 to approximately 400 feet downstream of Pagenkopf Road
Ryan Lake	Entire shoreline with Hennepin County
Six Mile Creek	From the confluence with Halstead Bay to approximately 200 feet upstream of Highland Road
Twin Lakes	Entire shoreline with Hennepin County
Unnamed Ponding Area Southwest of Hadley Lake	Entire shoreline with Hennepin County

This Countywide FIS Report

As part of this countywide FIS, updated analyses were included for the flooding sources presented in Table 4.

Table 4 – Scope of Revision (This Countywide FIS Report)

Flooding Source	Limits of Revised or New Detailed Study
Crow River	The area restudied is known as North Point of the river in the City of Rogers. The reach was from approximately 8,200 feet downstream of State Highway 101 to approximately 4,600 feet downstream of State Highway 101
Minnehaha Creek Watershed	Entire length using XP-SWMM to include Minnehaha Creek, Gleason Creek, Painter Creek, Six Mile Creek, and Long Lake Creek
Minnesota River	From the confluence with the Mississippi River to the Wright County boundary
Nine Mile Creek Watershed	Entire Length using XP-SWMM to include Braemer Branch, Braemer Branch (Split Flow), Nine Mile Creek (County Ditch 34), Nine Mile Creek (Main Stem), Nine Mile Creek (North Branch), and Nine Mile Creek (South Branch).

Table 5 presents Letters of Map Change (LOMCs) incorporated into this countywide study:

Table 5 – Letters of Map Change

LOMC	Case Number	Date Issued	Flooding Source(s)/Project Identifier
LOMR	05-05-1906P	April 8, 2005	Shingle Creek, Palmer Lake Park Preserve
LOMR	05-05-2244P	June 27, 2005	Hillswick Trail and York Lane
LOMR	05-05-3454P	July 28, 2006	Plymouth Creek, Summer Creek – GM Homes

The following tabulation lists streams that have names in this countywide FIS other than those used in the previously printed FIS reports for the communities in which they are located.

Old Name	New Name
Braemer Branch South Fork Nine Mile Creek	Braemer Branch
Nine Mile Creek	Nine Mile Creek (Main Stem) and Nine Mile Creek (North Branch)
South Fork Nine Mile Creek	Nine Mile Creek (County Ditch 34) and Nine Mile Creek (South Branch)

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development and proposed construction.

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and Hennepin County.

2.2 Community Description

Hennepin County, located in east-central Minnesota, has an area of 611 square miles. The county is bordered by Anoka County to the north; Dakota County to the east; Carver and Scott Counties to the south; and Wright County to the west. The 2010 Census indicates a population of 1,152,425 for the county (U.S. Census Bureau, 2012).

Summer temperatures range from an average monthly high of 84 degrees Fahrenheit (°F) in July to an average low of 60°F in September. Winter temperatures range from an average monthly high of 41°F in March, to an average monthly low of 7°F in January. The average annual precipitation is 30.15 inches (The Weather Channel, 2012).

The topography of the county ranges from flat areas, rolling hills and knolls, and interspersed marshland.

The principal industries in the county are general manufacturing, wholesale trade, and retail trade.

2.3 Principal Flood Problems

There are four watershed districts within the City of Minnetonka which regulate development in flood-prone areas. The Minnehaha Creek Watershed District was established on May 9, 1967, by order of the Minnesota Water Resources Board. The district generally includes the authority to regulate the flow and use of streams, to regulate improvements by riparian property owners, and to prepare and implement a management plan controlling development adjacent to the creek (MCWD, 1969).

The Riley-Purgatory Creek Watershed District was established July 31, 1969, by the Minnesota Water Resources Board. An overall plan for the watershed was adopted August 7, 1972, and published August 1973; since then, the plan has been periodically revised, as necessary.

Purgatory Creek frequently floods in Minnetonka due to restrictive hydraulic structures as well as the general wetland character of the watershed. Flood-related damages have not been extensive due in part to the lack of a velocity component.

The Nine Mile Creek Watershed District has delineated the limits of the 1-percent-annual-chance frequency floodplain along the creeks and major tributaries within the watershed; the delineation is developed from an “envelope” based on ultimate watershed conditions. The district has also adopted development review criteria; the district will not approve encroachment within the floodplain resulting in an increase in the regional flood level in that reach greater than 0.5 without an accompanying increase in the hydraulic capacity of the downstream constriction. In determining the increase in regional flood level, an equal degree of encroachment will be applied to land within the reach.

The district also requires that the basement floor or first floor in a building without basements be a minimum of two feet above the flood envelope at that location (Minnesota Water Resources Board and Nine Mile Creek Watershed District, 1973).

Flooding along Lake Minnetonka, in the Cities of Orono, Shorewood, Spring Park, Tonka Bay and Woodland, is due primarily to spring snowmelt runoff or intense summer rainfall events. Major floods were recorded on Lake Minnetonka in 1906 (2.3-percent-annual-chance), 1951 (2.2-percent-annual-chance), 1957 (8.3-percent-annual-chance), 1965 (4.0-percent-annual-chance), and 1969 (7.1-percent-annual-chance) (Hennepin County Highway Department, 1897-1977); the most severe flood recorded on Lake Minnetonka occurred in 1951 and had a recurrence interval of approximately 45 years. The most recent flood on Lake Minnetonka occurred in 1975 and was slightly larger than a 10-percent-annnual-chance event (Hennepin County Highway Department, 1897-1977). No historic flood information is available for Silver Lake, Silver Lake Branch of Purgatory Creek, the marsh area south of Edgewood Road and east of Howard's Point Road, or the marsh area south of Smithtown Road. No records of past flooding in these cities are known to exist. However, other floods have been recorded elsewhere on Lake Minnetonka. These floods have caused problems for numerous residents in and near the floodplain. There are no records documenting flood drainage and no existing flood laws in the City of Tonka Bay.

Those floodplain areas in the Cities of Orono and Mound which have been developed in the past contain residential development. Severe flooding along lakes in the City of Orono is due primarily to either spring snowmelt runoff or intense summer rainfall events. Restrictive characteristics of manmade structures and the general characteristics of the floodplains cause certain areas in city to be flooded.

Peak lake level readings available from 1961 to 1975 show the highest three peak levels as:

Year	Elevation (National Geodetic Vertical Datum of 1929 (NGVD))	Estimated Frequency (years)
1969	833.6	5.0
1970	832.9	1.9
1971	832.8	1.7

A permanent increase in lake levels occurred between 1964 and 1965 when an augmentation well and a recreational park were constructed, modifying the lake characteristics and shoreline. Damages have been limited during flooding and will probably remain so in the future due to the elevations of existing structures. Factors influencing flooding are the absence of an outlet from Bush Lake, and the interconnection between Bush Lake and Anderson Lakes.

Flooding on Lake Minnetonka, Black Lake, Seton Lake, and Emerald Lake occurred in 1906, 1951, 1957, 1965, and 1969 in the City of Mound. The most severe flood occurred in 1951 and had a recurrence interval of approximately 50 years. Flooding during the spring of 1964 on Langdon, Dutch, and Sanders Lakes has been recorded in detail. These floods have caused problems for numerous residents in and near the upland ponding areas, mainly because of inadequate drainage outlets. The most recent flood, in 1969, had a recurrence interval of 20 years.

Bush Lake is one of a chain of several lakes created by glacial action in the western Bloomington area. It is the deepest and most heavily used recreational lake in the area. Since Bush Lake is landlocked, flooding is due to tributary runoff from adjacent land areas and from the Anderson Lakes which adjoin Bush Lake to the west.

Flooding around the ponds and lakes in the City of Plymouth results from both spring snowmelt and intense summer rainstorms. The more severe flooding events tend to result from long duration spring snowmelt events due to the restrictive capacity of the lake and pond outlets. Numerous flooding events that have occurred in the past have not been recorded in detail, although residents recall damaging flooding.

Flooding around the ponds and lakes in the City of Crystal results from both spring snowmelt runoff and intense summer rainstorms. The more severe flooding events often result from long duration spring snowmelt events due to the restrictive capacity of the lake and pond outlets. The highest recorded flood levels around Gaulke, Brownwood, and Memory Lane Ponds occurred during the spring snowmelt in 1965. On April 11, 1965, the high water elevation was recorded at 877.8 feet NGVD on Gaulke Pond and 883.3 feet NGVD on Memory Lane and Brownwood Ponds. Numerous other flooding events which have occurred in the past have not been recorded in detail, although residents recall damaging floods resulting from intense summer rainstorms as well as spring snowmelt runoff.

Highwater on Sarah Lake in the City of Independence occurred in July of 1975; that event corresponds approximately to a 1-percent-annual-chance event recurrence interval and was caused by intense rainfall.

The combination of conditions that cause flooding in the City of Independence in 1965 are the most apt to cause flooding again. Floods of large magnitude are likely to occur when snowmelt from heavy snow cover is followed by intense spring rains.

The same hydrologic effect is achieved when long periods of rain are accompanied by an intense rain. Floods on the lower portion of Pioneer Creek in the City of Independence are more apt to occur as a result of high flood stages on the South Fork Crow River.

Flooding of the City of Medicine Lake results from both spring snowmelt and intense summer rainstorms. The more severe flooding events result from long duration spring snowmelt events due to the restrictive capacity of the lake outlet. Numerous past flooding events have not been recorded in detail.

Flooding in the City of Minnetonka has occurred both for summer rainstorms and spring snowmelt runoff. In general, the lakes, interconnecting streams, swamps, and bogs do not readily respond to individual hydro-meteorological events due to the large amount of floodwater storage. Rather, flooding more often occurs during longer term "wet" periods involving several consecutive high-intensity, long-duration storms or a wetter than normal spring.

Lake Edina, Lake Cornelia, and several smaller lakes and swampy areas, some of which are holding ponds for extensive storm sewerings, have some shoreline flooding problems.

Flooding around the ponds and lakes in the City of Robbinsdale results from both spring snowmelt runoff and intense summer rainstorms. The more severe flooding events tend to result from long-duration spring snowmelt events and the restrictive capacity of the lake and pond outlets.

The more severe flooding events for the southern part of Rice Lake result from flood events on Bassett Creek at the south end of the lake in the City of Golden Valley. A road crossing of Bassett Creek just downstream of Rice Lake restricts floodflows which results in temporary inundation and storage of floodwaters on Rice Lake. Numerous flooding events which have occurred in the past have not been recorded in detail, although residents recall flooding resulting from intense summer rainstorms, as well as snowmelt runoff.

Due to the natural storage in the Bass Creek watershed upstream from the City of New Hope, and the lack of development adjacent to the creek within the city until recently, there are no historical indications of past flood events in the New Hope area.

The history of flooding along Bassett Creek is long but the events have been recorded in little or no detail. A natural floodwater ponding area occurs just upstream of the conduit entrance mentioned in the previous section. Several industrial and commercial enterprises are located within that ponding area, and it is surrounded by residences. Only small flows can be carried by the existing conduit without inundating the commercial and industrial development. The larger floods will inundate residential areas as well (USACE, 1975a). Significant flooding is known to have occurred on July 7, 1978; April 27, 1975; June 6, 1974; in June

1942; and on September 5, 1903. The flood of September 5, 1903, was apparently the greatest of these, when 5 inches of rain in 10 hours was reported and some 400 acres in the center of the city were flooded (USACE, 1975a). Elevation and discharge data for these floods are fragmentary or nonexistent.

The Bassett Creek Flood Control Commission was formed in 1969 by adoption of a joint powers agreement between nine municipalities which have all or part of their total area located within the watershed. The affected communities include: the Cities of Crystal, Golden Valley, Medicine Lake, Minneapolis, Minnetonka, New Hope, Plymouth, Robbinsdale, and St. Louis Park. A Watershed Management Plan for Bassett Creek was prepared and adopted by the Bassett Creek Flood control Commission on May 18, 1972. The plan delineated the 1-percent-annual-chance frequency floodplain and established a "management envelope" or elevation below which future development would be restricted. The management of this "envelope" will preserve the various options available for flood control until a plan which meets the needs of the public can be implemented. The plan is based on ultimate watershed development and includes the effects of proposed hydrologic and hydraulic changes which do not presently exist. Within the "envelope," the commission and member municipalities can act in a regulatory and restrictive capacity to preserve desired floodplain options (Bassett Creek Flood Control Commission, 1972).

Regulatory control over the entire management envelope will only be required while the subsequent phases of watershed planning are being completed. When a portion of the final development plan has been determined, the commission can cease to exercise jurisdiction.

In the City of Plymouth, flooding along Bassett Creek and Plymouth Creek occurs primarily due to intense summer rainstorms as well as spring snowmelt runoff.

In the City of Crystal, flooding along Bassett Creek, North Branch Bassett Creek, and County Ditch No. 18 Branch F, occurs primarily due to intense summer rainstorms. A large number of isolated flooding events have occurred in the past, but have been recorded in little or no detail. Residents, however, recall damaging floods in 1975, 1974, and 1972. The damaging floods which occurred in April 1975 and June 1974 are estimated as 4-percent-annual-chance flood events.

Flooding in the City of Golden Valley has occurred both from summer rainstorms and spring snowmelt runoff. The large number of isolated flooding events which have occurred have been recorded in little or no detail. Residents have indicated that while most of the isolated instances of damaging flooding have resulted from summer thunderstorms, flooding has not been strictly limited to that cause. Flooding following high-intensity rainstorms has occurred above locations in the creek where the discharge capacity has been limited by a culvert of an inadequate channel.

The potential for flooding along Bassett Creek is quite great due to the urbanized nature of the watershed, the many creek crossings by roads or other constrictions, and the lack of storage sites along the channel. Serious flooding has not been extensive since the watershed has not recently experienced a high-intensity storm with a generalized distribution over the entire watershed. The most recent case of severe flooding occurred in July 1978.

Major floods have occurred in 1903, 1942, 1974, 1975, and 1978. On September 5, 1903, 5 inches of rain in 10 hours caused extensive flooding at the conduit entrance in north Minneapolis. Flooding occurred at the conduit entrance in north Minneapolis in June 1942. This event has been estimated as the 2-percent-annual-chance event (USACE, 1976). Lack of development minimized damages in the City of Golden Valley.

On June 6, 1974, 5.5 inches of rain in a 6-hour period caused sanitary sewer back-up in the City of Golden Valley due to excessive infiltration into wastewater collection facilities. Also, many street intersections and other low-lying areas were inundated. This was estimated as a 4-percent-annual-chance event.

On April 27, 1975, 2.5 inches of rain in a 24-hour period aggravated saturated antecedent conditions causing a flood estimated as the 4-percent-annual-chance event. Excessive infiltration into wastewater collection facilities caused sanitary sewer back-up. Also, many street intersections were inundated. The low area between Regent Avenue and Lilac Drive experienced flood damages.

Flooding from a summer rainstorm which dropped three to five inches of rain over the watershed in two hours on July 6, 1978, caused content and structural damage to homes located between Regent Avenue and Lilac Drive. This corresponds to a 1-percent-annual-chance event in this area. Flooding also resulted in the inundation of walkout basements adjacent to Bassett Creek, sanitary sewer back-up, and intersection flooding.

Low-lying areas of the Cities of Greenfield, Hanover, Rockford, and Rogers are subject to periodic overflow from the Crow River. The most severe flooding occurs in early spring as a result of heavy rain and snowmelt. Major floods of the Crow River occurred in 1890, 1897, 1906, 1916, 1952, 1957, 1965, and 1969. Damages occur primarily to agricultural properties located near the Crow River. Data for past floods on the Crow River listed below were recorded at a USGS gage at the City of Rockford, Minnesota, that has a drainage area of 2,404 square miles.

Year	Discharge Cubic Feet Per Second (cfs)	Estimated Frequency (years)
1965	22,400	220
1969	15,100	42
1952	13,900	32
1957	13,500	28
1890	13,500[1]/12,800[3]	28/24
1906	11,000[2]/10,400[3]	15/13
1916	10,600	13

[1]Estimated by USACE from a high-water mark near the City of Dayton, Minnesota
[2]Estimated by USACE from a discharge measurement at the City of Dayton, Minnesota
[3]Adjusted from the City of Dayton to the City of Rockford using drainage area ratio to the 0.6 power

Principal obstructions to flow consist of Hanover Dam and an old bridge below the dam. The bridge causes an approximately two-foot stage increase; Hanover Dam causes an approximately one-foot increase and is not considered a flood control structure.

In December of 1971, severe ice jamming occurred downstream of the dam and upstream near Elk River Bridge the 1965 flood stage was exceeded; but, no flood threat occurred around the Coon Rapids pool (USACE, 1973d). Draining the pool for the winter eliminates formation of a heavy ice sheet at pool level and lowers the profile elevation at which ice jams would form throughout the reach from the dam to the City of Champlin, so that if ice jams should form, several feet of backwater may occur before normal pool level is reached, depending on whether the jam formed.

As a result, backwater from ice jams in the City of Champlin is no longer believed to be a factor affecting the elevation-frequency relations at the level of the 10-percent-annual-chance frequency, or greater, flood.

In the case of Elm Creek, street and highway crossings have caused constrictions and alterations in the topography, and have increased the flood potential in some areas. On Elm Creek, there is a weir at the upstream side of U.S. Highway 169, with a box culvert spillway near the highway. The weir is fitted with flashboards to maintain the water level upstream in Mill Pond at an elevation slightly above 845 feet NGVD. At high flood gates, the weir becomes submerged and the culvert spillway and the embankment of U.S. Highway 169 become the controlling features. During floods approaching the 1-percent-annual-chance frequency-discharge, flow will overtop the highway and flood into the residential area to the west and north of the junction of U.S. Highways 52 and 169. During the flood of April 1965, the ice sheet in Mill Pond floated over the weir, partially blocking the spillway. As a result of the increased pond elevation, a small flow to the north occurred in the highway ditch upstream of U.S. Highway 52. Storm sewers in the area west of the highway junction were able to contain the flow and no flood damage was sustained. Knowledge of past floods in the City of Maple Grove is limited. Residents have indicated that flooding, to date, has not caused significant damage, and that the highest water level was reached in June 1974. Another less severe flood is reported to have occurred in April 1965.

The April 1965 flood resulted from a combination of snowmelt-rainfall runoff event. Approximately 2 inches of rain fell during the first two weeks of April and combined with the runoff from a snow cover that contained from 6 to 9 inches of water. The combined runoff caused flooding along Elm Creek, particularly downstream of the City of Maple Grove.

The June 1974 flood event was the result of a long-duration rainfall event in which approximately 7.7 inches of rain fell in 13 days, with approximately 4.5 inches falling during the last 4 days of the period.

Residents of the Elm Creek Basin indicate that, no flooding has yet caused significant damage in the City of Medina. The largest flood, a 4-percent-annual-chance event, occurred in April 1965 and was caused by the runoff from a very deep snow cover, with a water content of 6 to 9 inches, coupled with about 2 inches of rain. High water also occurred in June 1974 when 7.7 inches of rain fell in 13 days at the City of Maple Plain, close to the southwest edge of the basin. This flooding also had a 4-percent-annual-chance return period.

The combination of hydrologic and meteorologic conditions which caused flooding in 1965 and 1974 are most apt to cause flooding in the basin. The largest floods are likely to occur when deep snow cover with high moisture content melts, fills the natural storage areas in the basin, and is followed by a high rate of runoff from intense rainfall. The same effect is achieved when long periods of precipitation are followed by an intense rain.

In the City of Wayzata, the major cause of flooding on Gleason Creek is the spring snowmelt event. There are no discharge records and no known historic flood information for Gleason Creek in the City of Wayzata. The causes of flooding along Gleason Creek in the commercial area of the City of Wayzata are primarily due to the restrictive channel crossings.

The low-lying areas of the City of Edina adjacent to Minnehaha Creek, Nine Mile Creek (North Branch), and Braemer Branch are subject to flooding caused most often by intense thunderstorms. During the storm of August 30, 1977, several areas flooded. During that storm, 7.27 inches of rain were recorded in a four-hour period at the Minneapolis-St. Paul International Airport. On Minnehaha Creek, the resultant peak flow was estimated as a 40-percent-annual-chance recurrence interval. This low recurrence interval was due to an unusually low antecedent moisture condition. However, in areas where the percent of impervious areas is high, considerable flooding occurred.

Flooding on Minnehaha Creek is complicated by the presence of Lake Minnetonka. Lake Minnetonka water-surface elevations are controlled by a dam at Gray's Bay, the source of Minnehaha Creek. Sustained high flow in Minnehaha Creek is caused by outflow from Lake Minnetonka. In general, a rise in the lake level and eventual overflow at Gray's Bay Dam correlates with greater than average precipitation. This correlation does not always hold true since temperature, precipitation intensity, and antecedent conditions significantly affect the amount of floodwater runoff (Minnehaha Creek Watershed District, 1969).

The upstream reaches of Minnehaha Creek in the City of Minnetonka do not have a history of severe flooding. Recent flooding occurred in 1965 and 1966, with the 1966 flood being considered the flood of record. A limited amount of sandbagging, pumping of basements, and other flood protection measures were employed during these events. The damage incurred as a result of these floods consisted mainly of contents damage (Minnesota Water Resources Board and the Riley-Purgatory Creek Watershed District, 1973).

Due to the lack of documentation, historic highwater elevations are generally unavailable. Elevations have been supplied by the City of Minnetonka for this FIS (City of Minnetonka, 1977), and are based on field surveys of highwater marks for past flood events. This data indicates a maximum elevation at the Gray's Bay Dam of 928.97 feet NGVD on March 4, 1966. This is approximately one-foot lower than the estimated 10-percent-annual-chance lake elevation of 929.95 NGVD. The maximum elevation at Hazelwood Outer Drive, upstream Interstate Highway 494 reached 928.90 NGVD and occurred on May 5, 1975. Several other highwater marks are approximate in nature and are not considered appropriate for inclusion in this FIS.

Minnehaha Creek is capable of flooding not only from shorter duration rainstorms, but also from spring snowmelt runoff and longer duration storms. In general, the lakes, interconnecting streams, swamps, and bogs, which constitute a large portion of the tributary area, do not readily respond to individual hydrometeorological events due to the large amount of floodwater storage. Rather, flooding occurs during longer term "wet" periods involving several consecutive high-intensity, long-duration storms or a wetter than normal spring.

Residential structures downstream of Monk Avenue (Blake Road) and in the vicinity of Lake Street have historically been inundated. Due to the lack of documentation, historic high water elevations are generally unavailable and recurrence intervals are unknown.

Several severe floods along the Minnesota River have occurred in recent years, the most notable occurring in April 1965 when a peak flow of 117,000 cfs was recorded, and in April 1969 when the peak flow was 84,600 cfs.

Flood problems in the City of St. Louis Park result from high stages occurring in Minnehaha Creek and in storm sewer ponding areas located throughout the city.

The storm sewer system and associated ponding areas were, in general, designed for the minor, more frequent storms.

The Mississippi River and Elm Creek in the City of Champlin are the major sources of flooding in the city. Flood stages in the City of Champlin, on both the Mississippi River and Elm Creek, are affected by dams.

The most notable floods on the Mississippi River occurred in 1952, 1965, and 1969, with flows of 75,900, 91,000, and 72,500 cfs, respectively. The flows were recorded at the USGS gage near Anoka (No. 05288500) (USGS, undated). Return period estimates are 29 years for the 1952 flood, 70 years for the 1965 flood and 24 years for the 1969 flood. Several small lakes in the city were investigated and found not to present a flood hazard to the city.

There have been three major floods on the Mississippi River in the past 71 years. These occurred in April 1952, April 1965, and April 1969. The discharges for these floods were 75,900 cfs, 91,000 cfs, and 72,500 cfs, respectively, and are for the gaging station (No. 05288500) near Anoka, Minnesota (USGS, 1970a; USGS, 1970b; USGS, 1968; USGS, undated). The estimated recurrence intervals for these floods are 29 years, 70 years, and 24 years, respectively.

Records of Mississippi River flood stages were obtained at the U.S. Highway 169 Bridge over the Mississippi River for the number of years during which the Northern States Power Company operated the dam and power plant in Coon Rapids. These records show that during the period of power plant operation, ice jams formed in the pool area behind the dam during the ice breakup period. The most severe ice backwater condition occurred in April 1965, when an elevation of 843.7 feet NGVD was recorded in the reach of the Mississippi River extending through the City of Champlin (City Commission of Anoka, 1966). This was a temporary, ponded operation that extended upstream for several miles. Recorded flow at the time of the ice jam peak was 33,000 cfs. This compares with profile elevations ranging from approximately 841 to 847 feet NGVD, occurring in the same reach at the time the peak flow of 91,000 cfs was recorded. The 1965 flood is the highest flood of record at the City of Champlin.

Low-lying areas of the City of Minneapolis adjacent to the Mississippi River, Minnehaha Creek, Shingle Creek, and Bassett Creek are subject to flooding, caused by snowmelt in combination with spring rains or by intense thunderstorms. Maximum discharges on Minnehaha Creek were determined for the May 1965 peak of 368 cfs at 50th Street in the City of Edina and 500 cfs at Hiawatha Avenue in the City of Minneapolis and are believed to be the highest known at those locations since 1943. More recently, the flood of August 31, 1977, was measured by indirect methods as 916 cfs at Cedar Avenue as the 2-percent-annual-chance event. This flood peak developed from runoff in the Cities of Edina and Minneapolis and was largely absorbed in Lake Mokomis and Lake Hiawatha, which were at low level prior to the event. The previous peak at the other 2 locations listed above was not exceeded in the event of August 31, 1977. During the flood of August 31, 1977, several homes in the vicinity of West 51st Street and Logan Avenue South were flooded, and overflow occurred through the commercial area near West Minnehaha Parkway and Cedar Avenue South. Flooding is aggravated along Morgan Avenue and West 51st Street by the restrictive nature of culverts under James and Logan Avenues a short distance downstream. Flooding from ice jams and ice forming within the culverts at James and Logan Avenues has occurred on several occasions, but notably in February 1966 following a period of snowmelt and rain when a flow of 142 cfs occurred at Hiawatha Avenue.

Low-lying areas of the City of Dayton adjacent to the Mississippi and Crow Rivers are subject to flooding caused most often by snowmelt in combination with spring rains. The area most affected is near the mouth of the Crow River where the older residential and small commercial developments were built within the floodplain. Several major floods causing overflow in that area have occurred on the Mississippi and Crow Rivers in the past 70 years; notable are those of 1952, 1965, and 1969 (USGS, 1970a; USGS, 1970b). The largest flood was that of 1965 with a flow of 87,200 cfs, which is very near the 1-percent-annual-chance flood, estimated to be 85,500 cfs.

At U.S. Highway 169, there is an extensive ponded area with a wide overflow section along the highway, which results in a broad sheetflow area upstream and downstream from the roadway. This sheetflow area drains directly to the Mississippi River floodplain.

In the City of Brooklyn Center, areas immediately adjacent to the Mississippi River on the gently sloping banks and low-land and marshes along the small streams are subject to periodic flooding, and as a result have not been developed. Areas within and around shallow depressions and along small streams in the northern part of the community are subject to flooding from local runoff during heavy rains and/or rapid snowmelt.

Flooding usually occurs in the spring when snowmelt combines with spring rain. Flood damages occur where structures are located within low areas along small streams and become flooded from accumulation of runoff during heavy rainfall or rainfall combined with snowmelt. Problem areas are generally small, and occur along Shingle Creek and the north end of Twin Lakes.

Flood damages occur where structures are located within low areas along small streams and become flooded from accumulation of runoff during heavy rainfall or rainfall combined with snowmelt. Agricultural crops and farm structures are damaged near depressions and in lowlands along small streams also during heavy rainfall events. Problem areas are generally small and scattered around the community.

The Nine Mile Creek Watershed District was established on September 30, 1959, by the Minnesota Water Resources Board. The initial overall plan for the watershed was adopted in 1961 and revised in 1973; a further revision took place in 1979. The watershed district regulates all improvements in the floodplain; the primary and initial regulation begins with state-approved floodplain and shoreland management ordinances enacted by the communities. To aid in carrying out the management plan, the district has established 1-percent-annual-chance profile "envelopes" based on ultimate watershed conditions, and valuable improvements which can be damaged by water will not be permitted in the floodplain (Minnesota Water Resources Board and Nine Mile Creek Watershed District, 1973).

Factors affecting flooding along Nine Mile Creek (Main Stem) include the use of natural and man-made retention ponds, and management of floodplain development through the implementation of an ultimate development water management plan. Restrictive hydraulic structures cause significant stage increases.

Flooding in the City of Hopkins results from both summer rainstorms and spring snowmelt runoff. Nine Mile Creek (North Branch) has its beginning in the City of Hopkins, just north of Excelsior Boulevard. The area adjacent to Nine Mile Creek (North Branch) in the City of Hopkins is predominantly urban in nature. Natural drainage in the community is not well defined, and the city has installed an extensive storm sewer system. As a result, Nine Mile Creek (North Branch) is very responsible to short-duration, high-intensity rainstorms.

The August 1977 storm (7.25 inches in 5 hours) resulted in the overtopping of roadways, inundation of low-lying (uninhabited) areas, and the washing out of a service road culvert. Water-surface elevations were observed to approach the top of the County Road 18 embankment (Old Washington Avenue), and to overtop Ninth Avenue by about 0.5 foot. The water-surface elevation for the flooding which occurred at Ninth Avenue correlates to a 2.5-percent-annual-chance event. The August 1977 storm impacted the watershed unevenly and the recurrence interval for this storm decreases in an upstream direction; more detailed information is unavailable in those areas. Structural damage at County Road 18 and Ninth Avenue is non-existent. The Nine Mile Creek (North Branch) floodplain between 7th Street and County Road 18 is naturally flat and primarily comprised of marsh land. This area is effective in storing floodwaters; the 1-percent-annual-chance discharge decreases downstream of County Road 18.

Flood stage and discharge records have been recorded on Nine Mile Creek (Main Stem) at a site upstream of 102nd Street in City of Bloomington. A major flood occurred on April 8, 1965, which had a discharge of 535 cfs and a recurrence interval of 300 years. Another major flood occurred on June 1, 1968, which had a discharge of 298 cfs and a recurrence interval of 9 years.

Floodwaters on Nine Mile Creek have historically inundated lower levels of several homes along Nine Mile Creek (Main Stem) in City of Bloomington. Damage has generally been confined to contents damage due to backwater effects.

The lack of documentation for Nine Mile Creek (Main Stem) precludes establishment of flood elevation and attendant recurrence intervals. The lack of adjacent development in Hopkins has resulted in limited historic flood damages.

Development in the North Branch Bassett Creek floodplain has occurred over a longer period of time. There has been historical reference to flood events throughout the Bassett Creek watershed. These will be documented as follows: On September 5, 1903, 5 inches of rain in 10 hours caused extensive flooding at the conduit entrance in North Minneapolis; in June 1942, flooding at the conduit entrance in North Minneapolis has been estimated as a 2-percent-annual-chance event (USACE, 1976); on June 6, 1974, 3.5 inches of rain in a 6-hour period, a 4-percent-annual-chance event, caused sanitary sewer back-up in the City of New Hope due to excessive infiltration into wastewater collection facilities. Also, many street intersections were inundated; and on July 6, 1978, a summer rainstorm dropped 3 to 5 inches of rain over the watershed in a period of 2 hours, causing flooding along the North Branch Bassett Creek within the City of New Hope. Flooding reached an elevation of 888.63 NGVD at the Boone Avenue crossing (New Hope Public Works Department, 1978). This corresponds to a 1-percent-annual-chance event. Flooding resulted in inundation of walkout basements adjacent to the North Branch Bassett Creek, some sanitary sewer back-up, and intersection flooding. This storm also produced some basement flooding along Bass Creek.

In the City of Corcoran, interviews with local residents indicate that the largest flood on North Fork Rush Creek occurred in April 1965 and is estimated as the 4-percent-annual-chance event. This flood was caused by runoff from a deep snow cover, with a water content of 6 to 9 inches, coupled with about 2 inches of rain the first two weeks of April. Residents of the City of Corcoran stated that 97th Avenue and County Road 30 were overtopped. There is no available information on the extent of the damage incurred from this flood.

The combination of hydrologic and meteorologic conditions which caused flooding in 1965 are most apt to cause flooding in the basin. The largest floods are likely to occur when deep snow cover with high moisture content melts, fills the natural storage areas in the basin and is followed by a high rate of runoff from intense rainfall. The same effect is achieved when long periods of rain are followed by an intense rain.

Flooding in the City of New Hope has occurred both from summer rainstorms and spring snowmelt runoff. The large number of isolated flooding events which have occurred have been recorded in little or no detail. Residents have indicated that while most of the isolated instances of flooding have resulted from summer thunderstorms, flooding has not been strictly limited to that cause. A recent incidence of severe flooding was due to a combination of long duration spring rainfall and snowmelt. On April 27, 1974, about 2.25 inches of rain fell in a 24-hour period, generally throughout the watershed tributary to the City of New Hope. Although this storm approximated a 1-percent-annual-chance rainfall event, its effects were probably comparable to a 4-percent-annual-chance frequency runoff event due to antecedent conditions (USACE, 1976). A substantial spring snowmelt ended approximately April 15, and was followed by several days of moderate precipitation. As a result of the snowmelt and subsequent period of moderate precipitation prior to the 27th, the soils throughout the watershed were in a saturated condition and much of the natural upland depression storage was full prior to the rainfall event of April 27th.

There is very limited knowledge of past floods in the City of Independence. There has never been a flood that has caused any significant damage. The largest flood on Pioneer Creek occurred in April 1986, as a result of backwater from the South Fork of the Crow River. That event had an approximate recurrence interval of 50 years and was caused by snowmelt coupled with spring rains.

There are no streamflow records available for Bass Creek, Eagle Creek, Shingle Creek, and Ryan Creek. Extensive natural storage areas along these creeks significantly affect their runoff characteristics.

2.4 Flood Protection Measures

In the Cities of Corcoran, Crystal, Dayton, Edina, Greenfield, Hanover, Independence, Maple Grove, Medicine Lake, Minneapolis, and Plymouth, there are no flood protection measures.

The City of Corcoran is currently participating in the NFIP. However, at the present time, a complete floodplain management program has not been implemented.

In the City of Edina, several projects are proposed by the Nine Mile Creek Watershed District (Minnesota Water Resources Board and Nine Mile Creek Watershed District, 1973) and the MCWD (MCWD, 1969). These proposals include retaining swamps and ponding areas for floodwater storage to reduce downstream floodings.

The principal means of flood protection in the City of Edina are the provisions of the National Flood Insurance Act of 1968, as amended, and the Minnesota State Flood Plain Management Regulations (Minnesota Department of Administration, 1970). The enforcement of these acts and regulations will preclude development in the floodplains in the City of Edina.

The Cities of Brooklyn Center, Brooklyn Park, Crystal, Dayton, Edina, and Robbinsdale have policies in place to aid in floodplain management.

The City of Crystal has adopted a floodplain zoning ordinance in accordance with the Minnesota Floodplain Management Act of 1969. The ordinance does not preclude floodplain development, but rather guides the type and extent of future development permitted in a floodplain consistent with the flood potential. Future development of vacant floodplain areas will be discouraged unless development can be protected from flood damage. Floodplain regulations will tend to preserve floodplain areas, particularly floodways, as open space.

In the City of Dayton, in planning for the future use of land, however, measures have been undertaken to reduce the possibility of increasing flood damage potential. All of the land adjacent to Hayden Lake and Elm Creek in the City of Dayton, all of the land adjacent to Rush Creek downstream from County Highway 121 south of Elm Creek Road, and much of the land adjacent to Diamond Creek downstream from Zanzibar Road is either in Elm Creek Park or is proposed for park use. This will prevent development in those areas and reduce the potential for flood damage.

The City of Robbinsdale has adopted a floodplain zoning ordinance in accordance with the Minnesota Flood Plain Management Act of 1969. The ordinance does not preclude floodplain development, but guides the type and extent of future development permitted in a floodplain consistent with the flood potential. Future development of vacant floodplain areas will be discouraged unless development can be protected from flood damage. Floodplain regulations will tend to preserve floodplain areas, particularly floodways, as open space.

There are no permanent flood protection structures in the Cities of Brooklyn Center and Brooklyn Park. Other measures of flood protection in the included development of a management plan for Shingle Creek (Barr Engineering Company, 1974) which defined flood profiles for the creek that were utilized by the City of Brooklyn Center in regulating development. The profiles were developed using methods less detailed than required for this study and are generally lower than profiles for comparable flooding frequencies reported herein. The management plan profiles provided an awareness of the hazard of locating structures near the creek and, with freeboard required by the city, resulted in placing structures along the creek at sufficient elevation to generally prevent flooding. The channel of Shingle Creek has been dredged and the alignment changed through the City of Brooklyn Center. The management plan calls for development of storage areas to help reduce flood losses. No implementation of these plans is expected before 1983.

In March 1976, the USACE, St. Paul District, completed a Feasibility Study for Flood Control on the main stem and tributaries of Bassett Creek, Medicine Lake and North Branch Bassett Creek (USACE, 1976). The study developed several structural and nonstructural improvements to the watershed that would result in protection against a flood having a 1-percent-annual-chance event. At that time, a design option was found to be cost beneficial and was selected for future consideration. In the fall of 1978, Congress authorized $200,000 for final design studies. Presently, the final design and construction dates for the proposed plan is uncertain. Due to the inherent uncertainty of design and timing, none of the following features of the selected plan were included in the hydraulic and hydrologic analysis.

Development within the floodplain is controlled by the Nine Mile Creek Watershed District. Their policies are based on ultimate development of the watershed. The City of Bloomington has already been installed as a regular member of the NFIP and the MDNR has approved the city-enforced floodplain zoning ordinances.

Both the Minnehaha Creek and Nine Mile Creek Watershed Districts regulate development in the floodplains of the City of Hopkins. The Minnehaha Creek District was established on May 9, 1967, by order of the Minnesota Water Resources Board. The district generally includes the authority to regulate the flow and use of streams, to regulate improvements by riparian property owners, and to prepare and implement a management plan controlling development adjacent to the creek (MCWD, 1969).

The Nine Mile Creek Watershed District was established on September 30, 1959, by the Minnesota Water Resources Board. The initial overall plan for the watershed was adopted in 1961 and revised in 1973 (Minnesota Water Resources Board and Nine Mile Creek Watershed District, 1973); and was further revised in 1979 (U.S. Water Resources Council, 1977).

The Watershed District regulates all improvements in the floodplain; the primary and initial regulation begins with state-approved floodplain and shoreland management ordinances enacted by the communities. To aid in carrying out the management plan, the district has established 1-percent-annual-chance profile “envelopes” based on ultimate watershed conditions, and valuable improvements which can be damaged by water will not be permitted in the floodplain (Minnesota Water Resources Board and Nine Mile Creek Watershed District, 1973).

The City of Medicine Lake and the Bassett Creek Flood Control Commission currently regulate development in the floodplain in the City of Medicine Lake.

In the City of Bloomington, Marsh Lake Dam, one of the main structural controls on Nine Mile Creek, has created a large floodwater retention basin; this, in turn, causes a significant mitigation in flood discharge peaks. While there are other storage areas throughout the watershed, these have little impact on the study reach.

In the City of Golden Valley, there are no existing federal or state flood control projects located in the Bassett Creek watershed. The fixed spillway-like level control dam on Medicine Lake (located upstream of County Road 18 in the City of Plymouth) restricts the outlet capacity of the lake and provides temporary storage of floodwaters. A lake level control structure on Sweeney Lake and the downstream crossings restrict the discharge capacity contributing to flow on the main stem and provides temporary storage of floodwaters. The primary purpose of these control structures is to maintain normal lake levels during non-flood periods.

The City of Orono has floodplain and shoreline zoning in effect; however, the limits of these zones are not based on detailed engineering studies. Upon completion of this study, the city will be required to adopt a floodplain zoning ordinance approved by the MDNR and the FIA.

In the City of Champlin, two management measures in effect reduce the flood hazard and potential for flood damage in the City of Champlin. First, the operating procedure for Coon Rapids Dam, whereby the pool level is lowered during the winter, effectively reduces the formation of ice jams, and flooding from that cause, along the Mississippi River in the City of Champlin. Secondly, all of the land adjacent to Lemans Lake and a considerable area in the floodplain of Elm Creek, near the outlet of Haydens Lake, is either in Elm Creek Park or is land proposed for park use. This will prevent development in those areas, and reduce the potential for flood damage.

Existing channel crossings of Bassett Creek restrict flood flows and provide substantial inundation storage which significantly reduces the major flood peaks. The locations of significant areas of existing inundation storage are the Brookview Golf Course, Bassett Creek Park, Rice Lake, and Theodore Wirth Park. Further flooding occurs in a natural ponding area downstream of Lilac Drive.

In the City of Rogers, the Berning Mill Dam is located on the Crow River just south of County Highway 116. However, it has been determined that the dam does not protect from rare events, such as the 1-percent-annual-chance event. No other flood protection measures are known to exist within the study area.

The upstream watershed areas of Riley-Purgatory Creek in the Trunk Highway 7 and County Road 101 area are currently undergoing considerable modification. The changes include channel realignment and enlargement, provision for additional floodwater storage, culvert enlargement and replacement, and raising of roadway grades. This work was computed in fall 1979. These drainage modifications are considered in sections 3.1 Hydrologic Analyses and 3.2 Hydraulic Analyses.

The Hennepin County Highway Department constructed County Road 18 over Nine Mile Creek, replacing Washington Avenue. The entire roadway within the creek valley was elevated on pilings, allowing the floodplain in this area to breathe. The original Washington Avenue grade was not changed during construction, and the original hydraulic structure has been retained. Therefore, the hydraulic characteristics of this portion of the stream valley have not been significantly altered.

In the City of New Hope, the USACE has been authorized by Congress to study flooding problems within the North Branch Bassett Creek watershed. The plan selected for additional analysis includes modification of certain restrictive hydraulic structures and provision for additional storage areas, both within and adjacent to the 1-percent-annual-chance floodplain. While modifications to the North Branch are anticipated, none will affect the reach within the City of New Hope. Floodplain development controls administered by the FIA and the Bassett Creek Flood Control Administration are deemed sufficient to keep floodplain damages at the present minor level. The Bassett Creek Flood Control Administration was formed in 1969 by adoption of a Joint Powers Agreement among nine municipalities which have all or part of their total area located within the Bassett Creek watershed. The Commission mandate is to prepare a management plan, insure compliance with that plan, and insure cooperation in its implementation. The plan was prepared and adopted in February 1972, and has been used for the management of water resources, floodplains, and associated land uses.

The management plan includes 1-percent-annual-chance profile "envelopes" based on ultimate watershed conditions anticipated at the time of the study and is therefore more restrictive than profiles prepared for the FIS based on existing conditions. Modifications contained in the report and scheduled for the City of New Hope have been completed. These consist of provisions for additional storage upstream of the 36th Avenue North tunnel entrance. The report also states for the Rockford Road Storage Site: North of County Road 9 and west of County Road 18 in the City of Plymouth is an area which is programmed for commercial and multiple residential development. In the center of this area lies a potential storage site which may be developed either as a large inundation area or a small inundation area with a pond. Details of this proposed ponding area have been discussed in a report to the City of Plymouth regarding storage requirements in the area. This plan proposes the same general method for development except that the flood elevations and volumes shown represent those relating to a 1-percent-annual-chance frequency. The management plan has not considered any storage in this area which would not be long term – that is, total storage of the 1-percent-annual-chance runoff (60 acre-feet) with a detention time in the neighborhood of 7 to 10 days. This storage site is required in conjunction with the other storage sites recommended for this branch of the creek in order to provide long-term, total storage of the 1-percent-annual-chance runoff and provide a smaller, more uniform discharge to the main channel (Bassett Creek Flood Control Commission, 1972).

Along Bass Creek, a restrictive hydraulic structure located 4,200 feet downstream from the the City of New Hope corporate limits is scheduled for replacement during the summer of 1979. This structure is located in the City of Brooklyn Park at Water Works Road. The replacement of this structure will lower water-surface elevations in the City of New Hope approximately 3.3 feet. There are no further flood protection measures anticipated for this stream reach.

In the City of Rockford, in March 1969, early river-stage forecasts indicated the approach of a flood of considerable magnitude. As a result, the USACE constructed 3,350 feet of emergency levees to protect the main business and residential sections of the city. Since much of the work on the levees was undertaken without foundation investigations and no control was maintained over the selection of materials or their placement, the existing levee cannot be regarded as reliable protection from a 1-percent-annual-chance flood. Levees that do not protect against the 1-percent-annual-chance flood are not considered in the hydraulic analysis of the 1-percent-annual-chance floodplain.

FEMA specifies that all levees must have a minimum of 3 foot freeboard against 1-percent-annual-chance flooding to be considered a safe flood protection structure. These levees do not meet these criteria.

The September 1975 “Report on Flood Control Alternatives, Crow River at Rockford” (USACE, 1975b) investigated structural improvements for flood control in the vicinity of the City of Rockford and concluded that such measures were not economically feasible.

There are currently no significant structural flood protection measures in the City of Minnetonka. The Gray’s Bay Dam in the City of Minnetonka is scheduled to be replaced by Spring 1980. The new structure will match the operating characteristics of the present structure; therefore, the 10-, 2-, 1-, and 0.2-percent-annual-chance lake levels will be unchanged. The new structure has been designed to retain storage over a longer period of time. This will stabilize the lake level of Lake Minnetonka and increase the Minnehaha Creek discharge during the normally dry summer months. The new structure will match the operating characteristics of the present structure. The new structure is to replace the old one, which is located approximately 2,000 feet southwest of McGinty Road (County Road 16) and Crosby Road intersection on Minnehaha Creek.

In the Cities of Mound, Orono, Shorewood, Spring Park, Tonka Bay, Wayzata, and Woodland, in 1897, an outlet dam for Lake Minnetonka was built to control lake fluctuations. The dam is located on Lake Minnetonka’s Gay’s Bay at the headwaters of Minnehaha Creek. Because the old structure is deteriorating, a new outlet structure has been proposed for a location further downstream of the existing structure. Because the new outlet structure is only in the planning stages at this time and will not be constructed for several years, it was not considered in the analysis for this study.

In the City of Woodland, development along the shoreline of Lake Minnetonka, where flooding results from high lake levels rather than from high stream flow, is regulated by the Minnesota Shoreland Regulations (MDNR, 1976).

The City of Mound enforces a zoning ordinance (Nason, Law, Wehrman and Knight, Inc., 1962) that controls the minimum elevation at which a building can be built on Lake Minnetonka, Dutch Lake, and Langdon Lake as means of flood control in the city. The flood protection elevations for Lake Minnetonka, Dutch Lake, and Langdon Lake are 933.5, 943.4, and 936.6 feet NGVD, respectively.

The City of Shorewood has a Wetland Ordinance regulating development within a designated wetland conservation area (Orr-Schelen-Mayeron and Associates, Inc., 1975). Upon completion of the City of Shorewood FIS, the city will be required to adopt a floodplain zoning ordinance in accordance with the FIA and the MDNR standards.

The Minnesota Department of Natural Resources has not approved of any flood zone ordinances for the City of Wayzata (MDNR, 1977b).

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the county, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this FIS. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates.

These events, commonly termed the 10-, 50-, 100-, and 500-year floods have a 10-, 2-, 1-, and 0.2-percent-annual-chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 1-percent-annual chance flood (1-percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the county at the time of completion of this FIS. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for the flooding sources studied in detail affecting the county.

Precountywide Analyses

Each community within Hennepin, with the exception of the Cities of Chanhassen, Deephaven, Eden Prairie, Excelsior, Greenwood, Long Lake, Loreto, Maple Plain, Minnetonka Beach, Minnetrista, Osseo, Richfield, St. Anthony, and St. Bonifacius has a previously printed FIS report. The hydrologic analyses described in those reports have been compiled and are summarized below.

Bush Lake is one of a chain of several lakes called the Anderson Lakes. Currently, Bush Lake has no outlet and the normal water-surface elevation is approximately six feet lower than that of the other lakes. Due to the natural channel between Anderson Lakes and Bush Lake, the hydrologic analysis of Bush Lake required the incorporation of the hydrology of all the Anderson Lakes. A rating curve for the outlet from Anderson Lakes to Bush Lake was developed from surveyed information by a backwater analysis using the USACE, Hydrologic Engineering Center (HEC), HEC-2 model (USACE, 1973c). After developing the storage-elevation relationships for Bush and Anderson Lakes, the Soil Conservation Service (SCS) Technical Release No. 20 (TR-20) hydrologic model was used to determine the runoff into Bush and Anderson Lakes. The 10-day runoff event was found to be the critical event. Flood elevations for Bush Lake are a result of the additional runoff volume input into Bush Lake. The 10-, 2-, 1-, and 0.2-percent-annual-chance Bush Lake elevations were found by applying the additional runoff volume to the storage-elevation relationship developed for Bush Lake.

For Eagle and Pike Lakes, the SCS, computer program, TR-20 (SCS, 1965) and the other methods discussed above were used to conduct the hydrologic analysis. However, the 24-hour duration rainfall from the U.S. Weather Bureau's Technical Paper No. 40 (U.S. Department of Commerce, 1961) was determined to be the critical storm event. Runoff hydrographs were developed and the peak floodflows and storage volumes were determined for the 10-, 2-, and 1-percent-annual-chance rainfall events.

The elevations of Medicine Lake for selected recurrence intervals are based on the rating curve for the outlet as developed by the USACE, HEC computer program, HEC-2 (USACE, 1973c) for Bassett Creek downstream of Medicine Lake.

For Medicine Lake, Hadley Lake, and the unnamed pond located immediately downstream of Hadley Lake, the long-duration spring snowmelt runoff events were found to produce the most severe flood events. The frequency runoff data for snowmelt events was developed using the SCS, computer program, TR-20 (SCS, 1965).

Peak floodflows for Medicine Lake, Hadley Lake, Pike Lake and Rice Lake were determined for the 10-, 2-, and 1-percent-annual-chance frequency rainfall events. The peak floodflow for the 0.2-percent-annual-chance event was estimated by extrapolation on log-probability paper of the flood discharges computed for frequencies up to 100 years.

Peak stages were determined for Lake Independence for the City of Medina FIS (FIA, 1980a). A statistical analysis of 19 years of peak elevations was performed by methods outlined in the Water Resources Bulletin No. 17A (U.S. Water Resources Council, 1976).

The peak elevations for Lake Sarah were obtained by Edwards and Kelcey, Inc. using the SCS, computer program, TR-20. Storms of 6-hour and 1-day duration were analyzed along with the 10-day runoff volume. The 10-day runoff was the critical event for all recurrence intervals. Rainfall amounts for the 6-hour and 1-day storms were taken from the National Weather Service Technical Papers No. 40 and No. 49, and the 10-day runoff volume was taken from the SCS "Hydrology Guide for Minnesota" (U.S. Department of Commerce, 1961; U.S. Department of Commerce, 1964; SCS, 1966). The starting lake elevation was chosen at the invert of the outlet channel at the abandoned railroad grade. The rating curve for the outlet of Lake Sarah was derived using the USACE, HEC computer program, HEC-2 (USACE, 1979). The starting elevations for the HEC-2 model were developed from a rating curve of the 60-inch pipe culvert at the Soo Line Railroad crossing of Sarah Creek which is approximately 400 feet downstream of the abandoned railroad. The cross section and geometric information for the HEC-2 model was obtained from survey data of Sarah Creek between the abandoned railroad grade and the Soo Line Railroad. This data was surveyed by Hennepin County and is contained in the MDNR Lakes Files. Storage elevation curves were determined from a USGS 7.5-minute advanced map with a contour interval of ten-feet (USGS, 1979).

Because of the numerous natural storage areas in the basin, the 10-day duration rainfall was selected as the critical storm event. The 1-percent-annual-chance, 10-day rainfall for this area was determined to be 10.8 inches from the U.S. Weather Bureau Technical Paper No. 49, published in 1964 (U.S. Department of Commerce, 1964). This produced an average runoff depth of 6.2 inches over the basin, which is comparable to the 1-percent-annual-chance runoff probability for this area.

A number of the largest lake and marsh areas were treated as reservoirs for flood routing. Stage-discharge data developed from water-surface profiles and stage-storage data developed from topographic maps of the floodplain were used to accomplish the routing (USGS, various dates).

Graphs of the routed peak outflow from the lake and marsh areas versus their drainage area were used to estimate the discharge at other locations in the study reaches. The lake and marsh outflow values were used since these values best account for the total natural storage in the basin.

In the City of Medina, peak stages were determined for the portion of the northeastern shore of Lake Independence that is located within the corporate limits of the City of Medina. Gage heights were obtained by the USGS from a gage located in the City of Maple Plain, Minnesota, with a period of record from 1951 to 1963. Readings were generally obtained at three-day intervals from late March or early April through November. The USGS gage heights are referred to a gage zero of 953.00 feet above mean sea level in 1912 adjustment. The maximum observed gage height for each year is also listed. Approximately maximum elevations were obtained for 1966, 1970-1973, and 1977 on Lake Independence by the Hennepin County Park Reserve District. These elevations are in NGVD adjustments. Daily observations are not available. The highest observed gage height for each year of the 13-year USGS record was added to the gage zero of 953 feet NGVD; 0.48 foot was then subtracted to convert to the NGVD. The maximum annual elevations for six years, in NGVD, in the Park Reserve District record were listed. The 19 annual maximum lake elevations were arranged in descending order and were assigned plotting positions in percent according to Weibull's method for a 19-year period (U.S. Water Resources Council, 1977). Although 19 years is not as long a record as would be possible, it does give the best elevation-frequency relationship currently possible.

The frequency analysis of historic water-surface elevations on Lake Minnetonka and the flood-frequency analysis for Dutch and Langdon Lakes were coordinated with the USACE, the USGS, the SCS, and the MDNR.

The SCS, computer program, TR-20 (SCS, 1965), was used for the hydrologic analysis of Dutch Lake and Langdon Lake. Using this program, the physical characteristics of the watershed, such as soil type, land use, land treatment, and hydrologic conditions, were used to predict the runoff volume for rainfall events of the selected frequencies. These characteristics were determined by using USGS topographic maps (USGS, various dates), MDNR Lake Sounding Maps (MDNR, 1958; MDNR, various dates), the Soil Survey for Hennepin County (SCS, 1974b), the SCS "National Engineering Handbook" (SCS, 1972), and field investigations. The 10-day duration rainfall event was determined to be the critical storm event for both of these lakes. The amounts of rainfall for the 10-, 2-, and 1-percent-annual-chance frequency events were determined from the U.S. Weather Bureau's Technical Paper No. 49 (U.S. Department of Commerce, 1964) and procedures outlined in the SCS "National Engineering Handbook" (SCS, 1972). The amount of rainfall for the 0.2-percent-annual-chance event was estimated by extrapolating on log-probability paper the amounts of rainfall determined for the 10-, 2-, and 1-percent-annual-chance events. Stage-volume and stage-discharge curves were developed using SCS, computer program, TR-20 (SCS, 1965). Stage-frequency curves were then developed from the stage-volume and stage-discharge curves.

A stage-frequency curve was developed for Lake Minnetonka using the Weibull formula (Chow, V.T., 1969) based on the historic water-surface elevations for the 77 years of record (1897-1904, 1906-1908, and 1910-1975). Lake levels for the period from 1931 to 1940 (inclusive) were not used in the flood frequency analysis due to a severe drought. This drought produced extremely low water levels, which were inconsistent with the balance of the records. USGS Flood-Prone Area Maps (USGS, 1973) were reviewed and found to be consistent with data developed in this study.

Lake levels recorded prior to 1897 were not used in the analysis because an outlet dam was built in Gray's Bay at the headwaters of Minnehaha Creek in 1897. Lake levels for the period 1931 to 1940, inclusive, were not used in the analysis because a severe drought during this period resulted in low water levels inconsistent with the balance of the record.

In the Cities of Mound, Tonka Bay, and Woodland, gaging station records provided the principal source of data for defining the stage-frequency relationship used in the analysis for Lake Minnetonka, Black Lake, Seton Lake, Emerald Lake, and the pond near Bradford Lane (Hennepin County Highway Department, 1897-1977). Gaging station records for Lake Minnetonka are on file at the Hennepin County Highway Department (Hennepin County Highway Department, 1897-1977).

Emerald Lake, Seton Lake, Black Lake, and the pond near Bradford Lane are directly connected to Lake Minnetonka; therefore, any frequency analysis of Lake Minnetonka's historic water-surface elevations is also a frequency analysis of Emerald Lake, Seton Lake, Black Lake, and the pond near Bradford Lane. Flooding of these smaller lakes occurs both as a result of inflow from local drainage areas and when there is a general condition of flooding on Lake Minnetonka. Water-surface elevations produced by local inflow to these areas were lower than those produced by the same selected frequency events on Lake Minnetonka. Therefore, water-surface elevations for the selected frequency events on Lake Minnetonka were determined to be the critical water-surface elevations for Emerald Lake, Seton Lake, Black Lake, and the pond near Bradford Lane.

Gaging station records for Lake Minnetonka are on file in the Hennepin County Highway Department (Hennepin County Highway Department, 1897-1977). The gage is located on the eastern side of State Highway 101 in Gray's Bay of Lake Minnetonka. Historic water-surface elevations for this gage are available dating back to 1820. The present outlet structure was built in 1897 and renovated in 1944. Records from 1897 to 1975 were used to analyze the stage-frequency relationship for Lake Minnetonka. Water-surface elevations provided by the Hennepin County Highway Department were recorded in 1903 (931.8) datum and converted to NGVD (930.9) datum by subtracting 0.9 foot.

The data from the stage-frequency curve for the stormwater levels for Lake Minnetonka in the study are shown in the following tabulation.

Water Elevation (feet) (NGVD)	Recurrence Interval (percent-annual-chance)
928.1	80
928.8	50
929.1	40
929.6	20
930.0	10
930.2	5
930.6	2
930.9	1
931.3	0.2

In the City of Shorewood, the statistical analysis of historic water-surface elevations on Lake Minnetonka was coordinated with the USACE, the USGS, the SCS, and the MDNR.

A hydrologic analysis was performed in the City of Mound FIS to establish the stage-frequency relationship for floods of the selected recurrence intervals on Lake Minnetonka (FIA, 1978b). The flood elevations used for the Lake Minnetonka shoreline of Shorewood and Enchanted Island in the City of Shorewood FIS were obtained from this hydrologic analysis.

In the City of Spring Park, the hydrologic analyses were conducted as part of the City of Mound FIS (FIA, 1978b) and were used as the stage-frequency relationships for Lake Minnetonka in this study.

The analyses reported herein reflect the stillwater elevations due to tidal and wind setup effects but do not include the contributions from wave action effect such as the wave crest height and wave run-up. Nonetheless, this additional hazard due to wave action effect should be considered in the planning of future development.

Lake Ardmore elevations and discharges of the unnamed tributary connecting the two lakes were obtained by routing hydrographs through Lake Ardmore. There are no gage records or discharge records in the Lake Ardmore basin or on the outlet stream. Consequently, synthetic methods were necessary for deriving inflow hydrographs into Lake Ardmore for routing through the lake (SCS, 1966). The drainage area at the outlet of Lake Ardmore was found to be 0.81 square mile, and the surface area of Lake Ardmore at a normal stage was measured as 9 acres. Hydrographs of inflow into Lake Ardmore for the selected recurrence intervals were computed by the SCS, computer program, TR-20 (SCS, 1965). The 10-day runoff depths, shown in the SCS Hydrology Guide for Minnesota (SCS, 1966) produced higher lake elevations and outflows than those from the one-day rainfall amounts shown in the National Weather Service Technical Paper No. 40 (U.S. Department of Commerce, 1961). An elevation-capacity curve for Lake Ardmore was derived from available maps and field surveys. The outflow rating curve was derived for a culvert just below the outlet of the lake. The routing through Lake Ardmore was performed by the SCS, computer program, TR-20 (SCS, 1965).

The maximum outflows of Lake Admore were used as peak discharges for the unnamed tributary connecting the lakes because the stream adds little to the drainage area in that region.

The 1-percent-annual-chance flood elevations for the marsh area south of Smithtown Road was determined using storm sewer information (Orr-Schelen-Mayeron and Associates, 1975), USGS topographic maps (USGS, various dates), and the U.S. Weather Bureau Technical Paper No. 40 (U.S. Department of Commerce, 1961). Runoff volumes for Silver Lake, and Silver Lake Branch of Purgatory Creek were estimated using two-foot contour interval topographic maps of the City of Shorewood (Orr-Schelen-Mayeron and Associates, 1966 and 1967), the Weather Bureau Technical Paper No. 40 (U.S. Department of Commerce, 1961), and USGS topographic maps (USGS, various dates).

The 1-percent-annual-chance flood elevations for Silver Lake, Silver Lake Branch of Purgatory Creek, and the other approximate study areas were estimated by the SCS, computer program, TR-20 (SCS, 1965), using the Bureau of Public Roads culvert nomographs (Federal Highway Administration, 1965), USGS topographic maps with a ten-foot contour interval (USGS, various dates), topographic maps of the City of Shorewood with a two-foot contour interval (Orr-Schelen-Mayeron and Associates, 1966 and 1967), the Weather Bureau Technical Paper No. 40 (U.S. Department of Commerce, 1961), and field inspection data. No hydraulic analyses were performed in this study for the detailed study area since flood elevations on Lake Minnetonka were determined by hydrologic methods.

For the ponds east of the French Lake area and the ponds near Carman Bay, computations were made by iterative methods to develop the water-surface elevations for the selected frequencies. Inflow into the first of the series of ponds was calculated by using the SCS, computer program, TR-20 (SCS, 1965). Culvert nomographs (Federal Highway Administration, 1965 and standard routing methods were used to develop the water-surface elevations for the ponds.

The hydrologic analysis of Fagerness Point, Baldur Park Point, and Rest Point was based on the hydrologic analysis of Lake Minnetonka. Gaging station records provided the principal source of data for defining the stage-frequency relationship used in the analysis of Lake Minnetonka.

For the northern part of Rice Lake, Grimes Avenue Pond, Memory Lane Pond, Brownwood Pond, Hagermeister Pond, and Gaulke Pond, long-duration spring snowmelt runoff events were found to produce the most severe flood events. The frequency runoff data for snowmelt events was based on 34 years of streamflow records for the Crow River in neighboring Wright County. Streamflow records for March, April, and May of each of the 34 years of record were analyzed to determine the 30 consecutive days with the highest mean discharge. Statistical analyses of 30-day mean discharges were accomplished by graphical methods. Analysis of mass curves for the months of March, April, and May for several additional streams in the metropolitan area provided a runoff-area relationship. The runoff-area relationship was then applied to the 30-day spring snowmelt frequency curve for the Crow River to determine the 30-day spring snowmelt frequency curve for the range of drainage areas. Synthetic hydrographs were developed for the 10-, 2-, and 1-percent-annual-chance events to determine the storage volume versus time relationships. The 0.2-percent-annual-chance event was estimated by extrapolation on log-probability paper of the flood events for frequencies up to 100 years.

For the northern part of Rice Lake and the Grimes Avenue Pond, the stage increase from the 2-percent-annual-chance frequency event to the 1- and 0.2-percent-annual-chance frequency events is negligible. The northern part of Rice Lake and the Grimes Avenue Pond are interconnected by a culvert through the railroad embankment which equalizes the water-surface elevations during a long-duration runoff event. The northern part of Rice Lake does not outlet into the southern part of Rice Lake until the road embankment separating the two parts of the lake is overtopped. When the road embankment separating the northern and southern parts of Rice Lake is overtopped, the flow over the embankment rapidly exceeds the inflow from the critical snowmelt event with negligible increases in stage. These stage increases are less than 0.05 foot and, therefore, the elevation difference between the 1-percent-annual-chance flood and the 2- and 0.2-percent-annual-chance floods is 0.0 foot.

For the southern part of Rice Lake, in the City of Golden Valley, the water-surface elevations of floods of the selected recurrence intervals were computed through the use of storage routing of the inflow hydrograph from Bassett Creek and the local tributary area. The discharge-elevation relationship is based on the rating curve for the outlet of Rice Lake in the City of Golden Valley, as developed by the USACE in the Bassett Creek Flood Control Feasibility Report (USACE, 1975a).

For the southern part of Rice Lake in the City of Robbinsdale, floodflow-frequency data were determined for the main stem of Bassett Creek using the unit hydrograph methods of the USACE, HEC computer program, HEC-1 (USACE, 1973b). Flood hydrographs were synthesized using the precipitation-frequency-duration data published in the National Weather Service's Technical Paper 40 (U.S. Department of Commerce, 1961). The synthetic hydrographs were determined in accordance with USACE procedures.

Flood elevations in the City of Robbinsdale could be raised by debris accumulations at culverts, however, the hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations, as given, are thus considered valid only if hydraulic structures, in general, remain unobstructed, operate properly, and do not fail. Likewise, changes in the existing hydraulic structure sizes or elevations could greatly affect the existing flood elevations.

The hydrologic analysis for this study was based on existing development conditions. Future urbanization of the area could alter the floodflow relationship developed for this study and future use of these data should include an evaluation of the effect of interim development.

Discharge values for the Bass Creek and North Branch Bassett Creek in the City of New Hope were submitted for review to an Inter-Agency Review Committee comprised of the MDNR, the SCS, the USGS, and the USACE, St. Paul District. Acceptance of the proposed discharge values was transmitted via letter dated March 10, 1978.

Bass Creek is one of four creeks contributing to the Shingle Creek watershed. Upstream of the confluence with Shingle Creek in Brooklyn Park, Bass Creek meanders through the Cities of Plymouth and New Hope with some contributing area lying within the City of Maple Grove. Significant floodwater storage is available in several major lakes and marshlands. Bass Lake, the largest lake within the watershed tributary to the study reach, provides the greatest single storage potential. Topography throughout the area is classified as gently rolling with large, flat marsh areas adjacent to the creek bed.

A preliminary hydrologic analysis of Bass Creek has been conducted by the USGS as part of the City of Brooklyn Park FIS (FEMA, 1995). The USGS applied regional regression equations for Region D in Minnesota, and applied an adjustment factor for urbanization (USGS, 1977). The required watershed parameters for the equations include drainage area, main stream slope, and the percent of existing storage plus 1.0 values for these parameters were defined by the USGS for Bass Creek just downstream of 62nd Avenue North. The computed 2-percent-annual-chance discharge of 330 cfs compared very well with the 2-percent-annual-chance discharge of 332 cfs determined by the Hennepin County Highway Department for the design discharge of Bass Creek at County Road 18 at the upstream corporate limits. The contributing drainage area between County Road 18 and 62nd Avenue North is approximately 0.4 square mile, and has some natural stormwater storage available.

Bassett Creek-Sweeney Lake Branch drains portions of the Cities of St. Louis Park and Golden Valley and joins the main stem in Wirth Park. Throughout most of this reach, the creek flows through a series of ponds and marshes and the channel is generally undefined. From the Minnesota Northern and Southern Railway (upstream of Glenwood Avenue) to the point where it flows into Sweeney Lake, a distance of 1.1 miles, the creek drops approximately 23 feet.

Sweeney Lake forms a large natural flood storage area due to a fairly restrictive outlet located just upstream of the confluence with the main stem. On Bassett Creek-Sweeney Lake Branch there are nine channel crossings in about a mile, all of which are restrictive to major flood flows. In addition, several upland storm drainage ponding areas provide substantial flood storage.

In the City of Crystal, County Ditch No. 18 Branch F, floodflow frequency data were determined using the unit hydrograph methods of the USACE, HEC computer program, HEC-1 (USACE, 1973b).

For flood flow-frequency analysis on the Crow River, data were obtained from the gaging station records collected by the USGS gage no. 05280000 at Rockford (USGS, undated).

In the City of Dayton, analysis of records for 48 years also followed the log-Pearson Type III method (U.S. Water Resources Council, 1967). A regionalized skew coefficient of -0.2 applicable to tributary streams of the Mississippi River in this area was used. The discharge-frequency relations were coordinated with the USACE at the 1-percent-annual-chance level and minor adjustments to the upper end of the flood flow-frequency curve were made to reflect the mutually acceptable 1-percent-annual-chance flow estimate. Flood flow-frequency estimates were then transferred to the mouth of the Crow River by drainage area ratio to the 0.6 power by inter-agency agreement. This resulted in a value of 29,500 cfs for the 1-percent-annual-chance flood for the Crow River through the reach in the City of Dayton.

For the Crow River in the Cities of Greenfield, Hanover, Rockford, and Rogers, the discharge-frequency curve was adopted from the Wright County, Minnesota, FIS (FEMA, 1992f). The portion of Rockford's gage record used to compute the discharge-frequency curve includes 65 years of data (1890, 1897, 1906, 1910-1917, and 1930-1983). The 1890, 1897, and 1906 discharge values were estimated by the USACE (USACE, 1986; USACE, 1968a; USACE, 1968b). The final analysis of these data resulted in an equivalent historic record of 94 years and an adopted skew of -0.34, after weighing with a regional skew of -0.20 and a mean square error of 0.125 as determined from the St. Paul District skew map (USACE, 1985).

Another analysis was done with three more years of flow data now available (1984-1986). The resulting discharge-frequency curve was nearly identical to the previously adopted curve. Therefore, adoption of the new curve is not justified.

For Eagle Creek, during the peak of the flood hydrograph, the roadway embankment of Boone Avenue will act as a dam causing floodwater to pond in the marsh area along Eagle Creek and restricting the flow from Eagle Lake in the City of Maple Grove to the west. Thus, Eagle Creek and its associated floodplain become a floodwater storage area for which a floodway is not applicable and Eagle Creek is not included in Table 9.

The 1-percent-annual-chance peak discharge for Edinbrook Channel, which was studied by approximate methods, was determined using the SCS, computer program, TR-20 (SCS, 1965).

Hydrology for Elm Creek, Rush Creek, and North Fork Rush Creek were examined in a report titled "Flood Hazard Analyses Elm and Rush Creeks, Hennepin County, Minnesota", which the SCS prepared (SCS, 1975a). No stream gage data are available for the study area of Elm Creek. Discharges for the selected frequency floods were estimated through the use of the SCS, computer program, TR-20 (SCS, 1965). In applying this program, the physical characteristics of the basin were used to predict the discharge that will occur from a rainfall event of a given frequency. Runoff depth for given rainfall depth was determined by the soil types, land use, land treatment, and hydrologic conditions in the basin. Hydrographs of runoff were developed and flood-routed through the stream reaches and the lakes and marshes to determine the peak discharge for the selected flood events. Because of the numerous natural storage areas in the basin, the 10-day duration rainfall was selected as the critical storm event. The 1-percent-annual-chance frequency, 10-day rainfall for this area was determined from the National Weather Service Technical Paper No. 49 to be 10.8 inches (U.S. Department of Commerce, 1964). This produced an average runoff depth of 6.2 inches over the basin, which is comparable to the 1-percent-annual-chance runoff probability for this area. The largest lake and marsh areas were treated as reservoirs for flood routing. Stage-discharge data developed from water-surface profiles and stage-storage data developed from topographic maps of the floodplain were used to accomplish the routing. Changes in existing bridge or culvert sizes or elevations could greatly affect the flood routings and the resulting peak discharge. The 1-percent-annual-chance flood discharges are in general agreement with regionalized discharge data developed by the USGS.

In the City of Maple Grove, for Elm Creek, Rush Creek, Fish Lake, and Rice Lake, the hydrologic analyses were provided by the SCS based on their Flood Hazard Study of the Elm Creek-Rush Creek watershed (SCS, 1975b). Flood flow-frequency data were determined using the SCS, computer program, TR-20 (SCS, 1965). Using this program, the physical characteristics of the watershed were used to predict the flood discharge that would occur from a rainfall event of the selected frequency. Runoff depth for a given rainfall depth was determined based on soil types, land use, land treatment, and hydrologic conditions in the watershed. The 10-day duration rainfall from the U.S. Weather Bureau's Technical Paper No. 40 (U.S. Department of Commerce, 1961) was determined to be the critical storm event. Hydrographs of runoff were developed, and peak floodflows were determined for the 10-, 2-, and 1-percent-annual-chance rainfall events.

The peak floodflow for the 0.2-percent-annual-chance event was estimated by extrapolation on log-probability paper of the flood discharges computed for frequencies up to 100 years. Rainfall discharges into the lakes were compared to the flows at the control structure. This resulted in the stage-frequency or water-surface elevation.

The hydrologic analysis for this study was based on existing development conditions. Future urbanization of the area could significantly alter the floodflow relationships developed for this study and future use of these data should include an evaluation of the effect of interim development.

In the City of Wayzata, the peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were developed for Gleason Creek using the SCS, computer program, TR-20 (SCS, 1965). This computer program was used since no stream flow gaging records exist. The hydrologic computer program develops the flood discharges by modeling the watershed's physical and hydrologic parameters.

Physical parameters modeled by the hydrologic computer program include storage, slope, and cover. From an analysis of storms of various durations, it was concluded that the 10-day spring snowmelt event produced critical flood discharges on Gleason Creek. The 10-day spring snowmelt event was obtained from the SCS National Engineering Handbook (SCS, 1972). Precipitation depth for the 0.2-percent-annual-chance event was obtained by a graphical projection of the 10-, 2-, and 1-percent-annual-chance depths.

Discharges for the shallow flooding area were determined by computing the difference between the capacity of the drainage pipe under Rice Street and the total discharge on Gleason Creek at that point.

The hydrologic analysis for the approximate study area, the inlet channel to Peavey Lake, used the USGS regression equations (USGS, 1977). Hydrologic computations for the Hadley Lake outlet are included in the hydrologic analysis for Gleason Creek.

In the City of St. Louis Park, a regional analysis of flow frequency was chosen in favor of single station analysis because the gaging station on Minnehaha Creek at the City of Minnetonka Mills, was in operation for only 12 years; and it reflects the outflow from Lake Minnetonka, which is significantly affected by storage. Also, the station is three miles upstream from St. Louis Park, and thus does not reflect flooding from local inflow through the study area.

Synthesized inflow flood hydrographs were developed using the unit hydrograph theory for the storms that produce the various frequency floods. Inflow volume was reduced by outflow volume for each area studied to obtain the net storage volume required for each ponding area.

Historic records of high and low water elevations on lake and ponding areas were furnished by the City of St. Louis Park. These were used, along with high water marks obtained during the flood of June 1974 and low water winter levels obtained by the USGS, to arrive at starting elevations for computing storage for each of the ponding areas.

Flood-prone areas not studied in detail were outlined on the basis of large-scale topographic maps, photographs, field inspections, and high-water elevations furnished by the City of St. Louis Park.

Outflow from Lake Minnetonka was later combined to give peak flows in the reach upstream from Lake Nokomis. Synthetic hydrographs of inflow were developed for Lake Nokomis utilizing peak inflow determined by the method described above with volumes of runoff determined by methods of the SCS (SCS, 1972). The runoff hydrographs were flood-routed through Lake Nokomis and Lake Hiawatha to determine maximum lake elevations and peak flows downstream to the mouth.

In the Cities of Hopkins and Minnetonka, a continuous recording gage was operated by the USGS for a period of 11 years (1953-1964) on Minnehaha Creek at the City of Minnetonka Mills. A log-Pearson Type III frequency analysis (U.S. Water Resources Council, 1977) performed on this data was found to be unreliable due to the short length of record and significant changes made to the upstream channel since the period of record. The SCS, computer program, TR-20 (SCS, 1965) was therefore used to analyze Minnehaha Creek because of its capability to model the significant storage component found in the watershed. The 10-day, 2-day, and 1-day storms (U.S. Department of Commerce, 1961; U.S. Department of Commerce, 1964) were applied to the watershed to determine the most severe conditions. The 2-day storm was found to be the critical event in the 10-, 2-, 1-, and 0.2-percent-annual-chance recurrence intervals. Storage-elevation curves for each of the hydraulic structures considered were developed using two-foot contour maps obtained from the watershed district (Minnehaha Creek Watershed District, 1973). Rating curves for the structures were computed using techniques contained in Federal Highway Administration publications (Federal Highway Administration, 1965; Federal Highway Administration, 1972; Federal Highway Administration, 1978).

Outflow from Lake Minnetonka at the Gay's Bay Dam is a major component to flow in Minnehaha Creek during each of the recurrence intervals analyzed in this study. Due to significant backwater effects, a normal weir relationship is not applicable to this outlet structure.

The normal weir relationship developed for the dam was corrected for backwater effects using discharge coefficients for submergence (USGS, 1978). The 10-, 2-, 1-, and 0.2-percent-annual-chance recurrence interval Lake Minnetonka levels, as determined by Barr Engineering Company for the City of Excelsior, Orono, and Mound FISs (FIA, 1977e; FIA, 1978b; FIA, 1978c), were applied to the adjusted rating curve to determine outflow from the lake. The overflow from the lake was combined with lateral inflow by the TR-20 model and routed through the storage areas. The 10-, 2-, and 1-percent-annual-chance floodflow frequency discharges so determined were later checked using regional flood frequency equations (USGS, 1977) a good agreement was obtained. The hydrology prepared for Minnehaha Creek was submitted to the HIRC for analysis. This Committee is comprised of staff members from the USACE, St. Paul District, the SCS, the USGS, and the MDNR. Approval was received by a letter dated July 22, 1977.

Minnesota River discharges were determined by the USGS for the City of Bloomington Type 15 FIS (FIA, 1976).

In the Cities of Champlin and Dayton, hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for the Mississippi River in the City of Champlin area.

In the Cities of Brooklyn Center, Brooklyn Park, Champlin, Dayton, and Minneapolis, data for flow-frequency analysis on the Mississippi River were obtained from two gaging stations' records collected by the USGS (USGS, undated). One station is located downstream from the City of Champlin, near Anoka; the other is upstream at Elk River, Minnesota (USGS, 1978; USGS, 1968). The flow-frequency relationships at the two sites were based on statistical analyses of peak discharges for a 40-year period (1931-1970) for the downstream gage, and for a 46-year period, extended to 54 years by correlation, at the upstream gage. These analyses followed the log-Pearson Type III method as outlined by the Water Resources Council (U.S. Water Resources Council, 1967; U.S. Water Resources Council, 1976). A regionalized skew coefficient of -0.15, applicable to the upper reach of the Mississippi River through the City of Champlin, was used in the log-Pearson analyses of both records. Upon coordination of the discharge-frequency relationships at the 1-percent-annual-chance level with the USACE, very minor adjustments were made to the upper end of the flow-frequency curves to reflect the mutually acceptable 1-percent-annual-chance flood estimates of 66,000 cfs at Elk River and 98,000 cfs near Anoka. Small additions based on drainage area changes were made in transferring those peak values downstream to the Minneapolis area. A divided flow situation exists at Nicollet Island. This diversion is known as the East Channel of the Mississippi River.

The 1-percent-annual-chance-flood discharge of 98,000 cfs in the City of Brooklyn Park was coordinated with the USACE. The 1-percent-annual-chance flood discharge is increased to 98,500 cfs at the City of Brooklyn Center based on the increase in drainage area. Flow distribution through the study area for the various frequency floods was derived from a flood discharge-drainage area relationship.

The hydrologic analysis prepared for Nine Mile Creek and Bush Lake was approved by the Inter-Agency Review Committee. This committee is comprised of representatives from the MDNR; the USACE, St. Paul District; the USGS; and the SCS.

The hydrologic analysis of Nine Mile Creek in the City of Edina was performed by Barr Engineering Company using a method of synthetic hydrographs which they developed. Their method, developed in the 1950s, has been compared to the USACE HEC-1 method and was found to have no significant differences (USACE, 1973b). Analysis of the 2-hour and 24-hour storms indicated the 2-hour storm was the critical event on Nine Mile Creek.

In the City of Bloomington, the hydrologic analysis for Nine Mile Creek consisted of several different methods. First, a log-Pearson Type III frequency analysis based on the U.S. Water Resources Council Bulletin No. 17 (U.S. Water Resources Council, 1976) was conducted using the 12 years of stream gage records for Nine Mile Creek. The gage is located 1.2 miles downstream of Old Shakopee Road along Nine Mile Creek. A regional skew of -0.15 was employed in the analysis. Annual peak discharges for the period 1963-1975 were utilized, with the exception of 1974, when data was not available because of gage difficulties.

Second, due to the short record length, a regional analysis involving 12 USGS stream gage stations was performed to determine base frequency curves for the hydrologic region encompassing the City of Bloomington. The 12 gage locations, gage numbers and years of record are as follows:

Location	Gage No.	Years of Record
Mississippi River near Anoka County	52885	45
Minnehaha Creek at Minnetonka Mills	52895	11
Rum River near St. Francis	52860	52
Elk River near Big Lake	52750	51
Mississippi River near the City of Elk River	52755	41
Mississippi River near St. Paul	53310	107
Ostego Creek near the City of Ostego	52737	11
School Lake Creek Tributary near St. Michael	52803	12
Fountain Creek near Montrose	52873.5	14
Otter Creek near Lester Prairie	52787	14
Nine Mile Creek in Bloomington	no number	12

The resulting base frequency curves displayed the ratio of the desired recurrence flood discharge to an index flood discharge for the two- and ten-year recurrence intervals. Drainage area-index flow curves were then developed for three gage stations considered most hydrologically similar to Nine Mile Creek. These gages were located at Minnehaha Creek at the City of Minnetonka Mills, Fountain Creek near Montrose and Otter Creek near Lester Prairie. Using this data, drainage area-frequency-discharge curves were developed for the region. Discharge was found to be proportioned to the drainage area to the 0.63 power.

Third, due to the construction of Marsh Lake Dam in the City of Bloomington in 1970, the discharges developed in the regional analysis were modified to incorporate the additional available storage volumes. Reservoir routing techniques were used in conjunction with the Mockus Dimensionless Hydrograph to define the mitigating effects of the Marsh Lake Dam on the peak discharges. The routed peak discharges for the 10-, 2-, 1-, and 0.2-percent-annual-chance recurrence intervals were used in computing water-surface profiles in the City of Bloomington.

The reach of Nine Mile Creek, in the City of Hopkins, studied by detailed methods extends from the storm sewer outlet at County Road 3 (Excelsior Boulevard) downstream to County Road 18 (Washington Avenue). An area of significant floodwater storage occurs upstream of County Road 18 and results in a reduction in floodflow frequency discharges in the downstream direction.

The reach of Nine Mile Creek considered in the City of Minnetonka FIS is located adjacent to an area of significant floodwater storage in the City of Hopkins. This storage area and roadway fill, Old Washington Avenue, traverses the floodplain causing a reduction in floodflow frequency discharges in the downstream direction.

For the Cities of Hopkins and Minnetonka, a log-Pearson Type III analysis (U.S. Water Resources Council, 1977) prepared for the gage located in the City of Bloomington (12 years of record) was found to be inapplicable due to the short gage record and the large amount of storage between the study area and the gage location.

Therefore, an SCS TR-20 analysis was prepared using subwatershed delineations prepared by the Nine Mile Creek Watershed District Engineer. Pertinent watershed characteristics were determined from topographic mapping (USGS, 1967), soils maps (University of Minnesota, 1974), storm sewer maps (City of Hopkins Engineering Department, 1966), and field inspection of the watershed.

Five storm durations were analyzed for each of the 10-, 2-, 1-, and 0.2-percent annual-chance occurrence intervals; these include the 10-day, 2-day, 1-day, 6-hour, and 2-hour storms. For each recurrence interval, the 6-hour storm was the critical event. Rainfall values for the different durations and the 10-, 2-, and 1-percent-annual-chance frequencies were taken from Technical Paper 40 (U.S. Department of Commerce, 1961) and 49 (U.S. Department of Commerce, 1964) of the National

Weather Service, with appropriate reductions made in the runoff curve numbers as required for the 10-day duration storm. The values for the 0.2-percent-annual-chance rainfall were found by extrapolation on log-probability paper. Reservoir routing for the lower reach (near County Road 18) was computed using discharge-elevation and storage-elevation curves obtained from the Nine Mile Creek Watershed District Engineer. Slight adjustments were required to match values used in the City of Edina FIS (FIA, 1979d).

In the City of Independence, the hydrology for Pioneer Creek, Lake Robina, and Lake Robina Tributary was examined in a report titled "Flood Hazard Study, Pioneer Creek, Spurzem Creek, and Lake Robina Tributary, Hennepin County, Minnesota", prepared by the SCS and the Hennepin County Soil and Water Conservation District (SCS, 1979). Since no stream gage data is available for the study area of Pioneer Creek and Lake Robina Tributary, discharges for the selected frequency floods were estimated through the use of the SCS, computer program, TR-20 (SCS, 1965). By applying this program, the physical characteristics of the basin were used to predict the discharge that will occur from a rainfall event of a given frequency. Runoff depths for a given rainfall depth was determined by the soil types, land use, and hydrologic condition of the basin.

Discharge hydrographs were developed for the 10-day duration runoff and the 1-day duration rainfall. Because of the numerous storage areas within the watershed, the 10-day duration runoff, as expected, was found to be the critical storm event.

In the City of Independence, graphs of the routed peak outflow from the reservoirs versus their respective drainage areas were used to estimate the discharge at other locations in the study area. The reservoir outflow values were used since these values best account for the total natural storage in the basin.

Pioneer Creek joins the South Fork Crow River about three miles south of the City of Delano. Since the drainage area of Pioneer Creek is less than 5-percent of that of the South Fork Crow River at the confluence, it was assumed for the floods considered in this study that the peak flow from Pioneer Creek would occur sooner than the peak flow from the South Fork Crow River.

Purgatory Creek in the City of Minnetonka was studied via detailed methods from County Road 3, Excelsior Boulevard, to just upstream of Ridgewood Avenue. This reach of Purgatory Creek consists of a combination of open and drain-tiled channels flowing south and southeasterly through a series of marshland areas. The drain tile channel is the remains of an agricultural drainage system installed in the 1920s. The combination of localized flat topography with a system of inadequately sized culverts presents a significant flood potential to the area. Flooding is generally due to stage increases caused by the hydraulic structures. The drainage patterns of some of the areas upstream of County Road 3 are poorly defined, with the occurrence of several landlocked subwatersheds throughout the basin.

In an effort to reduce the flooding potential, the City of Minnetonka retained an engineering firm to develop a plan for drainage modifications of the watershed in the State Highway 7 and County Road 101 area (Riley-Purgatory Creek Watershed District, 1976). Modifications include channel excavation provision of storage basins, increased discharge capacity at County Road 3, State Highway 7, and County Road 101, and finally, increasing the elevation of the roadbeds of State Highway 7 and County Road 101. The construction plans for the channel and culvert modification have been approved by the City of Minnetonka, the Riley-Purgatory Watershed District, and the MDNR.

The 1-percent-annual-chance discharges and water-surface elevations prepared by the Riley-Purgatory Creek Watershed District Engineer are based on ultimate conditions and assume the drainage modifications noted above (Riley-Purgatory Creek Watershed District, 1976). The study contractor verified the approved 1-percent-annual-chance discharges and water-surface elevations (determined by rating curve) as used by the design and approval agencies using the SCS, computer program, TR-20 (SCS, 1965). The FIA approval by the Government Technical Representative for use of hydrology based on ultimate watershed development was received on December 9, 1977, in response to Special Problem Report No. 4 dated December 2, 1977. The 10-, 2-, and 0.2-percent-annual-chance discharges were then calculated by the study contractor using the TR-20 model calibrated for the area.

The flood flow frequency discharge values and elevations were submitted to the Interagency Review Committee on January 10, 1978. Due to the fact that ultimate watershed conditions were used in preparation of the hydrology, approval of the committee was not required.

The hydrologic analysis of the South Fork Crow River was based on USGS gage no. 05279000 near the City of Mayer. The discharge-frequency curve for this station was adopted from the Wright County, Minnesota, FIS (FEMA, 1992f). Mayer's gage record includes 50 years of data (1934-1983). To improve gage short-term statistics, a correlation was done with the longer historic record of Rockford's gage according to Bulletin 17B two-station comparison criteria (USGS, 1982).

The discharge-frequency relationship for the South Fork Crow River was statistically correlated from 41 years of discharge records from the South Fork Crow River near the City of Mayer and 53 years of record from the City of Rockford. This resulted in an adjusted record of 52 years of record near the City of Mayer. The discharge-frequency relationship for the South Fork Crow River near the City of Mayer was transferred downstream from the City of Mayer using the drainage area ratio to the 0.4 power.

The discharge-frequency curve near the City of Mayer was transferred downstream to the study locations by the drainage area ratio transfer method, using an exponent of 0.4.

The hydrologic analyses for Braemer Branch, South Fork Nine Mile Creek, Lake Edina, and Lake Cornelia were also performed by Barr Engineering Company. For these areas, the SCS, computer program, TR-20, was used (SCS, 1965). In these areas, the 24-hour storm was found to be the critical event. Rainfall volumes used in these analyses were taken from the U.S. Department of Commerce, Weather Bureau, Technical Paper No. 40 for the 10-, 2-, and 1-percent-annual-chance frequency storms (U.S. Department of Commerce, 1961). Storage in the ponding areas was determined using the best available two-foot contour topographic maps at a scale of 1:2,400 (Johnson, H. S., 1974). Travel times were estimated by field inspection and culvert nomographs. Subwatershed hydrographs were combined and routed through the watershed using channel and reservoir routing methods. The 10-, 2-, and 1-percent-annual-chance floods were determined using the procedures outlined above. The discharges for the 0.2-percent-annual-chance recurrence interval were determined by extrapolation on log-probability paper. The decrease in discharge on Nine Mile Creek results from the storage effect of the numerous lakes and ponds within the watershed.

As a result of the storm of August 30, 1977, local flood problems were brought to the attention of city officials and several minor improvements have since been proposed. One of the proposed improvements, that of raising the parking lot on the east side of Lake Cornelia, will block some flow from entering the lake and result in a slight lowering of flood elevations on Lake Cornelia. The city expects to have this completed during the summer of 1978. Therefore, the elevations for Lake Cornelia contained herein are for the proposed condition.

No stream gage records for the detailed study areas were available; therefore, for Plymouth Creek in the City of Plymouth, floodflow frequency data were determined using the unit hydrograph method of the USACE, HEC computer program, HEC-1 (USACE, 1973b). Flood hydrographs were synthesized using the precipitation-frequency-duration data published in the National Weather Service's Technical Paper 40 (U.S. Department of Commerce, 1961).

Peak floodflows for Plymouth Creek, were determined for the 10-, 2-, and 1-percent-annual-chance rainfall events. The peak floodflow for the 0.2-percent-annual-chance event was estimated by extrapolation on log-probability paper of the flood discharges computed for frequencies up to 100 years.

Hydrologic and hydraulic analyses for Rush Creek and North Fork Rush Creek in City of Corcoran, were made by the SCS, and the Hennepin Soil and Water Conservation District, Wayzata, Minnesota, as part of a flood hazard study. Two reports, which include a summary of the hydrology, have been published by the two agencies in cooperation with the MDNR and the Elm Creek Management and Protection Commission. The reports are "Flood Hazard Analyses, Elm and Rush Creeks," Hennepin County, Minnesota, 1975 (SCS, 1975a) and "Flood Hazard Analyses, North Fork Rush Creek, Hennepin County, Minnesota" (U.S. Department of Agriculture and the Hennepin Soil and Water Conservation District, 1977). The hydrology studies that were made for those reports included the four frequencies required for flood insurance purposes and were made by the latest detailed SCS methods. The results of the studies have been accepted for FISs. The 1-percent-annual-chance discharges have been accepted and approved by various Federal and state agencies.

No stream gage data are available for the study area Discharges for the selected frequency floods were estimated through the SCS, computer program, TR-20 (SCS, 1965). In applying this program, the physical characteristics of the basin were used to predict the discharge that will occur from a rainfall event of a given frequency. Runoff depth for given rainfall depth was determined by the soil types, land use, land treatment and hydrologic conditions in the basin. Hydrographs of runoff were developed and floodrouted through the stream reaches and the lakes and marshes to determine the peak discharge for the selected flood events.

For Shingle Creek, the regression equations from the new statewide, flood-frequency report were available to replace the index method of determining flood peaks upstream from floodwater storage areas (SCS, 1972). Several ponding areas along Shingle Creek upstream from the City of Minneapolis required the development of synthetic inflow hydrographs and flood-routing to determine peak flows entering the City of Minneapolis. The flow from Ryan Creek was added to get the final values applicable at the mouth. Ryan Creek is the outlet for Twin Lakes and Ryan Lake in the City of Brooklyn Center. Flood flows in Ryan Creek result from high elevations in the lakes. The conduit at the outlet of Ryan Lake controls the outflow from these lakes and limits the flow in Ryan Creek to the conduit capacity.

The hydrology of Shingle Creek in the City of Independence was coordinated with the Hydrologic Interagency Review Committee, consisting of members from the USACE, the SCS, MDNR, USGS, and the MNDOT, to eliminate the possibility of future conflicts. Interagency approval was received September 8, 1980.

Hydrologic analyses of Shingle Creek involved developing synthetic hydrographs of runoff from the various subwatersheds using methods of the SCS (SCS, 1972), combining hydrographs and reservoir routing through floodwater ponding areas utilizing storage-elevation data (Barr Engineering Company, 1979). Rainfall data utilized in the analyses are from technical papers of the Weather Bureau (U.S. Department of Commerce, 1961; U.S. Department of Commerce, 1964). Decrease in flood discharges through Palmer Lake is due to storage characteristics of Palmer Lake and its restrictive outlet. A similar analysis was carried out for Ryan Creek wherein Twin Lakes, Ryan Lake, and the connecting channel were found to function as one reservoir because of the restrictive nature of the culvert outlet. The floodplain along Ryan Creek becomes part of Ryan Lake which, during floods, extends to the outlet culvert under the Soo Line Railroad across the city border in the City of Minneapolis.

There are many large marshes along Shingle and Bass Creeks that comprise significant ponding areas and are effective in attenuating flood peaks. The hydrologic analyses of Shingle and Bass Creeks involved developing synthetic hydrographs of runoff from the various subwatersheds using methods of the Soil Conservation Service, combining hydrographs, and reservoir routing through floodwater ponding areas utilizing storage-elevation data provided by the engineering consultant from the community (SCS, 1972; Barr Engineering Company, 1979). Rainfall data utilized in the analyses were obtained from technical papers of the Weather Bureau (U.S. Department of Commerce, 1961; U.S. Department of Commerce, 1964).

Earthmoving and filling within floodwater ponding areas for development along Shingle Creek have been rapidly progressing without an overall plan. During the course of the November 17, 1981, study, the volume available for floodwater storage in the marsh between the Burlington Northern railroad track and Interstate Highway 94 was reduced by some 50-acre feet, resulting in increased peak flood discharges downstream to Palmer Lake. This necessitated revising flood discharges and recomputing the flood profiles before completing the floodway analysis.

In the City of Orono, the SCS, computer program, TR-20 (SCS, 1965) was used to predict the runoff hydrographs in the hydrologic analysis of the area at Chevy Chase Drive, the ponds west of the French Lake area, the Unnamed Tributary to Stubb's Bay, and the area near Carman Bay of Lake Minnetonka. This program develops the runoff hydrograph using characteristics of the watershed, such as soil type, land use, drainage area, and hydrologic conditions. Soil types were determined from available soil maps provided by the University of Minnesota (University of Minnesota, 1975). Land use and watershed boundaries were determined from USGS topographic maps (USGS, various dates). Rainfall for the 10-, 2-, and 1-percent-annual-chance frequency events was determined from the U.S. Weather Bureau's Technical Paper No. 40 (U.S. Department of Commerce, 1961) and the procedures outlined in the SCS National Engineering Handbook (SCS, 1972) for the area at Chevy Chase Drive, the area near Carman Bay, and the Unnamed Tributary to Stubb's Bay.

The rainfall for the 0.2-percent-annual-chance event was estimated by extrapolation of the 10-, 2-, and 1-percent-annual-chance events on probability paper. The 24-hour storm was determined to be critical for the area at Chevy Chase Drive, the ponds east of the French Lake area, the Unnamed Tributary to Stubb's Bay, and the area near Carman Bay. The 10-day snowmelt event was determined from the SCS "National Engineering Handbook" (SCS, 1972) to be critical for the ponds east of the French Lake area. The amount of runoff for the 4-, 2-, and 1-percent-annual-chance events was determined from the SCS "National Engineering Handbook" (SCS, 1972) for the ponds east of the French Lake area. The discharges for the 10- and 0.2-percent-annual-chance events were estimated by extrapolating the 4-, 2-, and 1-percent-annual-chance events on probability paper.

Stage-discharge and stage-storage relationships were developed for each hydraulic structure in the watersheds of the area at Chevy Chase Drive, the ponds east of the

French Lake area, and the Unnamed Tributary to Stubb's Bay by using two-foot contour maps developed from aerial photography (Barr Engineering Company, 1975), field investigation, USGS topographic maps (USGS, various dates), and culvert nomographs (Federal Highway Administration, 1965). Only stage-storage relationships were considered for the ponds near Carman Bay, since these ponds were landlocked. The aerial photography (Barr Engineering Company, 1975) and USGS topographic maps (USGS, various dates) were used to determine the stage-storage relationships in addition to a field investigation of the study area. The stage-discharge and stage-storage relationships for the area at Chevy Chase Drive and the Unnamed Tributary to Stubb's Bay were made a part of the TR-20 model hydrologic computer model of the study area.

September 2, 2004
Initial Countywide Analyses

Information on the methods used to determine peak discharge-frequency relationships for the streams restudied as part of this countywide FIS is shown below.

Standard hydrologic methods were used to determine the flood hazard data required for flooding sources studied in detail for the Bassett Creek watershed in and near the City of Minneapolis. Floods having recurrence intervals of 10-, 2-, 1-, and 0.2-percent-annual-chance have been selected as having special significance for floodplain management and flood insurance premium rates. The analyses reported here reflect current conditions in the Bassett Creek watershed.

The Bassett Creek watershed is located west of and is a tributary to the Mississippi River in the City of Minneapolis. The total area of the watershed exceeds 40 square miles and covers portions of the Cities of Crystal, Golden Valley, Medicine Lake, Minneapolis, Minnetonka, New Hope, Plymouth, Robbinsdale, and St. Louis Park.

Bassett Creek begins upstream of Medicine Lake in a branch known as Plymouth Creek. This branch of the creek begins in agricultural land east of the City of Hamel and flows generally east and south until it reaches Medicine Lake. This branch drains the central and southern portions of the City of Plymouth. Leaving Medicine Lake, the main stem of Bassett Creek flows to the east winding through the Cities of Golden Valley and Minneapolis before entering an underground conduit which conveys the flow approximately 1-1/2 miles to the Mississippi River.

There are two branches which join the main stem of Bassett Creek in its flow from Medicine Lake to the conduit. In the City of Crystal, the main stem is joined by the the City of North Branch, which flows southeasterly from the City of Plymouth through the Cities of New Hope and Crystal. In the City of Golden Valley, the main stem is joined by the Sweeney Lake Branch, which flows from the southern portions of the City of Golden Valley northeasterly to Sweeney Lake and joins the main stem in Theodore Wirth Park.

The Bassett Creek watershed is located on the edge of a rapidly expanding metropolitan area. Recent estimates of population growth within the watershed underscore the rapid growth of the area. As the watershed becomes increasingly urbanized, the runoff producing characteristics of lands are greatly altered. Large commercial and industrial development areas with large parking lots, paved storage areas, building of low height and large floor area will be built throughout the watershed. Storm sewer systems, streets and the development of residential areas will also increase the rate and quantity of runoff. The effect of these changes is to create a large increase in both the volume of runoff and the peak discharges at any point along the stream with corresponding increases in flood levels and anticipated potential flood damages. At the present time, approximately 65-percent of the watershed's total area is in a state of total or partial urban development. The state of urbanization varies from total within the City of Minneapolis, to negligible in the westernmost portions of the City of Plymouth. In the communities which have grown largely within the past 15 years, recent trends in land use have become apparent and many of these areas can be considered urbanized although the density of residential, commercial, and industrial developments is far less than that which is seen in the City of Minneapolis. Further west in the Cities of Minnetonka and Plymouth, the density of urban development becomes even less and urban planning to retain more park and green space is underway. The characteristics of runoff of each area in the watershed will be considerably different depending upon the land use and the density to which it is developed.

The existing and ultimate land use has been based upon current land use zoning maps, recent aerial photographs, quadrangle maps, field verification procedures, existing trends, and land use planning by the municipalities. The primary existing land use is residential, comprising approximately 50-percent of the total watershed area. Commercial and industrial land use comprises approximately 15-percent of the watershed area. Land set aside for parks, open space, public and semi-public use account for approximately 10-percent of the watershed area and 5-percent of the watershed area is occupied by open water. The remaining 20-percent of the watershed area is presently undeveloped. The vast majority of this undeveloped area will ultimately become residential and the remainder will become commercial and industrial development.

Hydrologic analyses were performed to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flood source studied in detail in the communities. Significant hydrologic information was utilized from analyses performed for the Flood Control, Bassett Creek Watershed, Hennepin County, Minnesota, Design Memorandum No. 1, Hydrology and Hydraulics (USACE, 1981) as published by the USACE, St. Paul District. The hydrologic analysis performed for the Interim Hydrology Report for Bassett Creek includes updated storage-outflow relationships for six structures that have been modified since the previous hydrologic analysis was performed for the May 1981

General Design Memorandum. The new analysis represents current basin conditions, including modifications of the State Highway 100 crossing.

A hydrologic basin model was developed using the USACE, computer program, HEC-1 and watershed parameters calibrated for two historic rainfall events. The watershed parameters were calibrated to observed high water marks for the two events. This is the best data available because there is no permanent streamflow gage in the basin. Precipitation data was obtained from U.S. Weather Bureau Technical Paper 40 (U.S. Department of Commerce, 1961) and HYDRO-35 (U.S. Department of Commerce, 1977) to complete the hypothetical rainfall event analyses.

The hydrologic model was developed from the watershed divide upstream of Medicine Lake to the conduit entrance in downtown Minneapolis. The model covers the entire Bassett Creek Watershed and represents the ultimate land use condition, which is the maximum urbanization expected to occur. The basin is now at or very near ultimate land use for areas downstream of Medicine Lake. Medicine Lake provides enough storage volume to effectively remove significant flow contributions from areas upstream of the lake for areas downstream of the lake. Therefore, the basin has effectively reached the ultimate land use condition with respect to runoff from a rainfall event.

This Countywide FIS Report

Floodplain areas of the lower Minnesota River were revised for this revision. In October 2001, the USACE produced the report “Section 22 Study: Minnesota River Main Stem Hydrologic Analysis” (USACE, 2001). This report has been reviewed and approved by the State of Minnesota. As done in the 1973 study, the discharge values developed for the gage near Jordan (USGS Gage 05330000) were used for the entire study reach.

The Nine Mile Creek flood study was revised by Barr Engineering in 2005. The detailed study delineated the 50 sq. mi. basin into a network of over 3,000 individual subbasins. The flood discharges and water surface profiles were determined with the XP-SWMM computer software (XP Software, Inc., 2004). In this study, XP-SWMM performed both hydrologic and hydraulic calculations for the floodplain determinations.

The base flood discharges were obtained from a 1-percent-annual-chance, 24-hr rainfall event. The rainfall event was the 1-percent-annual-chance, 24-hr rainfall depth from Technical Paper 40 (U.S. Department of Commerce, 1961) distributed over the time interval using the SCS Type II distribution. Landuse was obtained from aerial photography and other XP-SWMM studies for the region.

The Nine Mile Creek flood elevations were determined from crosssection data, channel roughness estimates, and structure survey and plan information. The cross-section data were generated from a combination of field-survey data and available two-foot contour topography, where the survey data was within the channel banks and were expanded into the overbank areas using the topographic data. Channel roughness estimates were determined by field inspection and photographs.

The Minnehaha Creek watershed flood study was revised with a comprehensive hydrologic/hydraulic model developed by Emmons and Olivier Resources, Inc. in 2005. The detailed study delineated the Minnehaha Creek basin into a network of 462 individual subbasins. The flood discharges and water surface profiles were determined with the XP-SWMM computer software. The XP-SWMM model performed both hydrologic and hydraulic calculations for the floodplain determinations.

For the upper watershed (the drainage area above Browndale Dam), the flood discharges were obtained from a 1-percent-annual-chance, 10 day rainfall depth. For the lower watershed (the drainage area below Browndale Dam), the flood discharges were obtained from the 1-percent-annual-chance, 7 day rainfall depth. Rainfall depths were distributed using the USACE, HEC computer program, HEC-HMS.

The Minnehaha Creek watershed flood elevations were determined from cross-section data, channel roughness estimates, and structure information. The cross-section and structure data were generated from a combination of existing HEC-2 models, GIS-based measurements, structure construction plans, and supplemental field surveys.

A summary of the drainage area-peak discharge relationships for all the streams studied by detailed methods is presented in Table 6.

Table 6 – Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
BASS CREEK					
At 62nd Avenue North	8.0	219	330	381	515
At Park Road	7.0	197	228	239	265
BASSETT CREEK					
At conduit entrance	39.6	674	1,048	1,222	1,631
At State Highway 55 (Wirth Park) inflow	37.7	1,274	2,208	2,662	3,696
At State Highway 55 (Wirth Park) outflow	37.7	402	578	678	907
Just downstream of State Highway 100 at 84-inch pipe	29.7	473	693	771	1,176
At State Highway 100 inflow	29.1	1,122	1,937	2,329	3,245
At State Highway 100 outflow	29.1	364	506	612	917
At Golden Valley Country Club inflow	22.9	232	339	404	563

Table 6 – Summary of Discharges *(continued)*

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
BASSETT CREEK (continued)					
At Golden Valley Country Club outflow	22.9	232	321	365	436
At Wisconsin Avenue (Brookview Golf Course) inflow	22.6	1,362	2,164	2,549	3,467
At Wisconsin Avenue (Brookview Golf Course) outflow	22.6	225	312	356	422
At Medicine Lake inflow	18.2	5,180	7,807	9,104	12,816
At Medicine Lake outflow	18.2	113	166	192	247
BASSETT CREEK - SWEENEY LAKE BRANCH					
Chicago and North Western Railroad	3.3	227	273	287	330
Minneapolis, Northfield, and Southern Railway	2.6	313	351	366	390
Lilac Drive	2.2	578	796	892	1,115
Minneapolis, Northfield, and Southern Railway	1.4	463	585	638	755
BRAEMER BRANCH					
At the confluence with Nine Mile Creek (South Branch)	*	45	67	89	121
Just upstream of Braemer Boulevard	1.2	282	369	442	535
BRAEMER BRANCH (SPLIT FLOW)					
At the confluence with Nine Mile Creek (South Branch)	*	57	118	275	529
CENTURY CHANNEL					
Just downstream of Tessman Parkway	1.8	*	*	163	*
Just downstream of Trail (downstream crossing)	1.8	*	*	146	*
Just downstream of Nevada North Avenue	1.7	*	*	138	*
At a point approximately 600 feet downstream of Nevada North Avenue	1.5	*	*	126	*
CROW RIVER					
Approximately 2.83 miles downstream of State Highway 101	2,760.0	11,000	22,900	29,500	48,300
Approximately 5.02 miles upstream of State Highway 116	2,590.0	9,800	16,600	19,900	27,700
At downstream corporate limits of City of Greenfield	2,560.0	9,730	16,500	19,700	27,500
Just upstream of State Highway 55	2,404.0	9,370	15,900	19,000	26,500

*Data not available

Table 6 – Summary of Discharges *(continued)*

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
ELM CREEK					
At confluence with Mississippi River	130.0	1,380	2,300	2,780	4,350
Above junction of Rush Creek, just inside corporate limits of City of Dayton	34.0	450	760	945	1,480
10.33[1]	28.8	410	690	860	1,345
12.52[1]	20.1	365	610	750	1,130
14.08[1]	17.5	345	570	690	1,020
16.73[1]	13.9	295	440	520	740
17.93[1]	11.0	270	390	450	650
At Medina-Plymouth corporate limits	6.6	185	230	245	330
Below Soo Line Bridge, near Hamel Road	6.1	170	205	210	305
Downstream of Hamel Road, near Pinto Drive	2.0	57	62	65	72
GLEASON CREEK					
At confluence with Lake Minnetonka	5.8	166	191	194	200
At confluence of Hadley Lake and Gleason Lake basins	3.3	88	109	123	157
LAKE ROBINA TRIBUTARY					
Approximately 0.2 miles upstream of confluence with Pioneer Creek	5.0	160	240	255	305
Downstream of County Road 92	3.3	13	40	55	80
Downstream of U.S. Highway 12	2.5	8	18	22	33
LONG LAKE CREEK					
At confluence with Minnehaha Creek	12.8	498	660	732	876
At cross section J	11.5	106	133	145	168
At cross section X	10.5	77	114	129	130
At cross section LLC-4nat	1.6	43	69	86	188
MINNEHAHA CREEK					
At the confluence with Mississippi River	176.0	882	1,417	844[2]	1,800
Approximately 450 feet upstream of 28th Avenue South	173.0	866	1,212	882[2]	1,580
Just downstream of Cedar Avenue South	168.0	767	1,208	1,196[2]	1,739
Just downstream of Humbolt Avenue	159.0	606	1,003	891[2]	1,459
Just downstream of Browndale Avenue	142.0	573	870	1,003[2]	1,340
Just downstream of State Highway 7	138.0	544	543	641[2]	949
Just downstream of Hopkins Crossroad	134.0	447	449	622[2]	739
Just downstream of Interstate Highway 494	129.0	420	414	580[2]	632

[1]Location corresponds to stream distances in miles above Mill Pond spillway in the City of Champlin (as shown on profiles)
[2]Discharge values assume that levee contains flood (levee is not accredited)
*Data not available

Table 6 – Summary of Discharges *(continued)*

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
MINNESOTA RIVER					
At Jordan gage (No. 05330000)	16,200.0	48,500	85,300	103,000	148,000
MISSISSIPPI RIVER					
Approximately 1.2 miles south of Interstate Highway 694	19,800.0	57,550	85,550	98,500	129,500
At southern corporate limits of City of Minneapolis	19,800.0	58,000	86,500	100,000	131,000
Upstream of Rice Creek	19,600.0	57,400	85,200	98,000	129,000
Approximately 0.5 miles downstream of Camden Avenue	19,300.0	57,700	85,900	99,000	130,000
Approximately 0.5 miles upstream of Camden Avenue	19,300.0	57,550	85,550	98,500	129,500
At Anoka County	17,300.0	50,200	74,800	85,500	113,000
NINE MILE CREEK (COUNTY DITCH 34)					
At the confluence with Nine Mile Creek (South Branch)	2.7	132	158	174	214
NINE MILE CREEK (MAIN STEM)					
Approximately 1.4 miles upstream of the confluence with Minnesota River	46.5	1,137	1,374	1,540	1,840
Approximately 0.6 feet upstream of West 98th Street	38.1	282	352	391	441
Approximately 380 feet upstream of Normandale Boulevard	32.4	838	912	991	1,078
NINE MILE CREEK (NORTH BRANCH)					
Just upstream of Interstate Highway 494	13.7	776	833	890	972
NINE MILE CREEK (SOUTH BRANCH)					
At the confluence with Nine Mile Creek (Main Stem)	18.0	154	183	197	219
Just downstream of Willow Creek Road	9.3	31	38	41	46
NORTH BRANCH BASSETT CREEK					
At confluence with Bassett Creek	3.2	325	485	595	860
Approximately 300 feet upstream of Brunswick Avenue	2.8	352	532	615	732
At 34th Avenue NorthInterstate 80	2.7	315	430	485	590
At Louisiana Avenue	2.5	190	275	315	400
At Winetka Avenue	2.1	45.8	47.8	48.8	50.4

Table 6 – Summary of Discharges *(continued)*

		Peak Discharges (cfs)			
Flooding Source and Location	Drainage Area (square miles)	10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
NORTH FORK RUSH CREEK					
Just downstream of Cain Road	16.3	340	485	530	700
Just downstream of Trail Haven Road	9.6	280	435	495	700
Just downstream of County Highway 10	4.0	160	265	310	420
Just downstream of Strehler Road	1.7	105	185	215	300
PAINTER CREEK					
At confluence with Minnehaha Creek	13.5	298	403	446	513
At cross section F	13.1	194	247	266	289
At cross section R	7.1	53	77	89	89
At cross section PC-2xsec2	1.1	41	56	64	64
PIONEER CREEK					
Downstream of County Road 157	37.6	400	585	650	790
Downstream of Copeland Road	27.3	370	555	620	740
Upstream of Robina Tributary	21.5	320	400	430	485
Downstream of County Road 92	20.5	310	375	395	440
Downstream of U.S. Highway 12	18.7	170	240	270	340
Downstream of County Road 90	16.5	115	190	220	290
PLYMOUTH CREEK					
At Station 0	7.0	1,346	1,654	1,780	2,100
At Station 10000	5.3	328	393	418	490
At Station 13000	4.4	478	579	620	720
At Station 23000	2.9	234	281	300	350
PURGATORY CREEK					
At County Road 3	4.0	526	589	630	690
At State Highway 7	3.2	236	285	310	368
At State Highway 101	2.3	125	150	160	181
At Ridgewood Avenue	1.0	22	29	32	38
RUSH CREEK					
At confluence with Elm Creek	50.4	770	1,170	1,330	2,000
5.00[3]	46.9	720	1,120	1,280	1,860
7.52[3]	22.7	390	600	680	960
At State Highway 101	19.1	335	510	570	810
Just downstream of County Road 116	13.1	285	420	470	680
Just above Unnamed Tributary approximately 0.3 miles downstream of County Highway 10	10.7	205	290	315	485
Just above Unnamed Tributary approximately 0.6 miles upstream of County Highway 10	8.2	160	215	230	375
At Jubert Lake outlet	3.2	40	50	150	300

[3]Location corresponds to stream distances in miles above confluence with Elm Creek (as shown on profiles)

Table 6 – Summary of Discharges *(continued)*

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
SHINGLE CREEK					
At confluence with Mississippi River	38.1	462	735	879	1,150
At south corporate limits of City of Brooklyn Center	27.7	460	704	827	1,120
At County Highway 10	26.8	378	600	701	980
At outlet of Palmer Lake	24.2	335	550	651	925
At north corporate limits of City of Brooklyn Center, near Plamer Lake	23.0	547	880	1,039	1,470
At 49th Avenue North	22.0	421	687	828	1,090
At Brooklyn Boulevard near Noble Avenue	19.9	435	680	794	1,100
At Douglas Avenue	17.4	339	491	559	732
At Burlington Northern Railroad	14.5	249	318	344	410
At Boone Avenue	11.2	210	240	250	275
SIX MILE CREEK					
At stream outlet into Lake Minnetonka	26.6	688	1,050	1,226	1,548
At Highland Road - upstream	23.9	234	342	394	518
At cross section SMC-27 nat	11.7	108	137	150	189
At cross section SMC-5 nat	4.5	39	70	78	89
SOUTH FORK CROW RIVER					
At confluence with main stem of Crow River	1,145.0	7,200	16,700	23,200	40,800
At upstream corporate limits of City of Greenfield	1,134.0	6,380	11,840	14,420	21,110
At county boundary	1,080.0	6,260	11,600	14,100	20,700
UNNAMED TRIBUTARY					
At confluence with Lake Ardmore	0.8	21	29	32	37
UNNAMED TRIBUTARY TO STUBBS BAY					
Approximately 4,730 feet above Lake Minnetonka	1.6	115	160	165	175
Approximately 1,700 feet above Lake Minnetonka	1.5	110	150	155	160

The stillwater elevations for Hennepin County are presented in Table 7.

Table 7 – Summary of Stillwater Elevations

Flooding Source	Water Surface Elevations (Feet NGVD) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
BROWNWOOD LAKE	*	*	*	*
BUSH LAKE	834	835.3	836.1	837.6
CENTURY CHANNEL PONDS	*	*	864.6	*
Pond 1	*	*	878.0	*
Pond 2	*	*	874.7	*
Pond 3	*	*	868.6	*
Pond 4	*	*	868.6	*
Pond 5	*	*	877.5	*
Pond 6	*	*	869.4	*
Pond 7	*	*	872.1	*
Pond 8	*	*	872.1	*
Pond 9	*	*	867.6	*
Pond 10	*	*	869.6	*
Pond 11	*	*	867.7	*
Pond 12	*	*	867.7	*
Pond 13	*	*	870.4	*
Pond 14	*	*	867.9	*
Pond 15	*	*	867.7	*
Pond 16	*	*	869.7	*
Pond 17	*	*	873.7	*
Pond 18	*	*	869.8	*
Pond 19	*	*	865.7	*
Pond 20	*	*	866.1	*
Pond 21	*	*	866.1	*
Pond 22	*	*	865.3	*
CRYSTAL BAY	*	*	*	*
DIAMOND LAKE	824.8	826.1	825.9	827.4
DUTCH LAKE	939.1	939.8	940.1	940.7
EAGLE LAKE	*	*	*	*
EDINBROOK CHANNEL PONDS				
Pond 15 - 85th and TH 252, SW	*	*	841.0	*
Pond 16 - 85th and TH 252, NW	*	*	845.2	*
Pond 17 - Murphy Estates, South	*	*	844.5	*
Pond 18 - Park Terrace Estates 2nd	*	*	848.6	*
Pond 19 - Edinburgh Center	*	*	846.0	*
Pond 20 - Brook Oaks Park	*	*	847.6	*
Pond 21 - TH 252 ROW adjacent to 22	*	*	848.7	*
Pond 22 - Irving Avenue adjacent to Pond	*	*	848.4	*
Pond 23 - Isles of Wight	*	*	846.8	*
Pond 24 - Golf Course, No. 17	*	*	849.4	*
Pond 25 - Maitland Park	*	*	849.1	*
Pond 26 - Highlands of Edinburgh, 6th (east)	*	*	850.1	*
Pond 27 - Highlands of Edinburgh, 6th (west)	*	*	851.9	*
Pond 28 - Highlands of Edinburgh, 5th	*	*	853.0	*
Pond 29 - Heart of Edinburgh, 2nd	*	*	850.2	*

*Data not available

Table 7 – Summary of Stillwater Elevations *(continued)*

Flooding Source	Water Surface Elevations (Feet NGVD) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
EDINBROOK CHANNEL PONDS (continued)				
Pond 30 - Heart of Edinburgh, 3rd	*	*	854.3	*
Pond 31 - Glen Echo of Edinburgh, 2nd	*	*	851.4	*
Pond 33 - Golf Course, No. 8 Tee	*	*	857.0	*
Pond 34 - Golf Course, No. 4 Tee	*	*	856.7	*
Pond 35 - Golf Course, No. 4 Green	*	*	856.6	*
Pond 36 - Golf Course, No. 6 Tee	*	*	856.3	*
Pond 37 - Highlands of Edinburgh, 3rd	*	*	856.2	*
Pond 38 - Stonehenge, dry at NWL	*	*	861.9	*
Pond 39 - Highlands of Edinburgh, 1st	*	*	853.9	*
Pond 40 - Creekside of Edinburgh, 2nd	*	*	858.5	*
Pond 41 - Edinburgh Park, 6th, dry at	*	*	857.9	*
Pond 42 - Trinity Gardens	*	*	859.0	*
Pond 43 - Gardens of Edinburgh, dry at	*	*	859.2	*
Pond 44 - Edinbrook Atriums	*	*	863.5	*
Pond 45 - Water Treatment Plant	*	*	857.7	*
Pond 46 - Police Facility	*	*	860.8	*
Pond 47 - Estates of Edinburgh	*	*	857.2	*
Pond 48 - Ponds of Edinburgh, 2nd	*	*	859.6	*
Pond 49 - Ponds of Edinburgh, SuperAmerica	*	*	860.9	*
Pond 50 - New South Wales	*	*	866.7	*
Pond 51 - Edinbrook Elementary	*	*	867.2	*
Pond 52 - Realife Co-Op	*	*	852.8	*
Pond 53 - Brook Oaks	*	*	847.8	*
Pond 76 - TH 610, Zane Avenue Interchange	*	*	876.4	*
FISH LAKE	*	*	*	*
GAULKE POND	*	*	*	*
GLEN LAKE	904.1	904.4	904.5	*
GRIMES AVENUE POND	*	*	*	*
HADLEY LAKE	*	*	*	*
HAGERMEISTER POND	*	*	*	*
HALSTED BAY	930.1	930.5	930.7	930.9
JENNINGS BAY	930.1	930.5	930.7	930.9
LAFAYETTE BAY	930.1	930.5	930.7	930.9
LAKE ARDMORE	961.4	962.0	962.3	962.7
LAKE CORNELIA	961.8	863.0	863.6	865.0
LAKE EDINA	823.4	824.0	824.5	825.6
LAKE INDEPENDENCE	958.3	959.2	959.5	960.1
LAKE MINNETONKA	930.1	930.5	930.7	930.9

*Data not available

Table 7 – Summary of Stillwater Elevations *(continued)*

Flooding Source	Water Surface Elevations (Feet NGVD) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
LAKE ROBINA	955.2	955.7	955.8	956.3
LAKE SARAH	980.1	980.9	981.2	981.8
LANGDON LAKE	933.7	934.2	934.5	934.7
MEDICINE LAKE	889.0	889.5	889.8	890.2
MINNEHAHA CREEK				
From McGinty Road to just downstream of the footbridge	930.1	930.5	930.6	930.6
From the footbridge to the dam	930.1	930.4	930.5	930.6
MEMORY LAKE POND	*	*	*	*
MOTHER LAKE	819.2	821.1	819.6	822.5
MUD LAKE	898.7	899.4	900.0	*
PONDS A AND B				
East of the French Lake area	930.0	930.6	930.9	931.3
POND C				
East of the French Lake area	930.0	930.7	931.0	931.4
POND D				
East of the French Lake area	930.1	930.9	931.2	931.7
POND E				
Chevy Chase area	963.0	963.6	963.7	963.8
POND F				
Chevy Chase area	960.0	960.4	960.5	960.8
POND G				
Carman Bay area	934.8	935.3	935.5	935.7
POND H				
Carman Bay area	934.2	934.4	934.5	934.7
RICE LAKE	*	*	*	*
TWIN LAKES AND RYAN LAKE	853.8	855.0	855.5	857.1
UNNAMED STREAM (DOWNSTREAM OF HADLEY LAKE)	*	*	*	*

*Data not available

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the source studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. For construction and/or floodplain management purposes, users are encouraged to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Cross sections were determined from topographic maps and field surveys. All bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry. All topographic mapping used to determine cross sections is referenced in Section 4.1.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the FIRM (Exhibit 2).

The hydraulic analyses for this FIS were based on unobstructed flow. The flood elevations shown on the profiles are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

All qualifying bench marks within a given jurisdiction that are cataloged by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and have a vertical stability classification of A, B, or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.

Bench marks cataloged by the NGS and entered into the NSRS vary widely in vertical stability classification. NSRS vertical stability classifications are as follows:

- Stability A: Monuments of the most reliable nature, expected to hold position/elevation well (e.g., mounted in bedrock)
- Stability B: Monuments which generally hold their position/elevation well (e.g., concrete bridge abutment).
- Stability C: Monuments which may be affected by surface ground movements (e.g., concrete monument below frost line).
- Stability D: Mark of questionable or unknown vertical stability (e.g., concrete monument above frost line, or steel witness post)

In addition to NSRS bench marks, the FIRM may also show vertical control monuments established by a local jurisdiction; these monuments will be shown on the FIRM with the appropriate designations. Local monuments will only be placed on the FIRM if the community has requested that they be included, and if the monuments meet the aforementioned NSRS inclusion criteria.

To obtain current elevation, description, and/or location information for bench marks shown on the FIRM for this jurisdiction, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their Web site at www.ngs.noaa.gov.

It is important to note that temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with this FIS and FIRM. Interested individuals may contact FEMA to access this data.

Precountywide Analyses

Each community within Hennepin, with the exception of the Cities of Deephaven, Eden Prairie, Excelsior, Greenwood, Long Lake, Loreto, Maple Plain, Minnetonka Beach, Minnetrista, Osseo, Richfield, St. Anthony, and St. Bonifacius has a previously printed FIS report. The hydraulic analyses described in those reports have been compiled and are summarized below. The elevations for the lakes are determined in the following manner. The lakes were treated as reservoirs for flood routing. Stage-discharge data developed from water-surface profiles (Federal Highway Administration, 1965; SCS, 1972; American Iron and Steel Institute, 1971; SCS, 1976) and stage-storage data developed from topographic maps (USGS, various dates) were used to accomplish the routing for Fish Lake and Rice Lake. For Eagle Lake and Pike Lake, the inflow hydrographs were routed in a similar manner; however, the rating curve for the Eagle Lake outlet structure was determined using weir flow equations and coefficients published by the U.S. Bureau of Reclamation (U.S. Department of the Interior, 1973).

In the City of Mound, the inflow hydrographs for Dutch Lake and Langdon Lake were routed through each lake by treating them as reservoirs. Stage-storage relationships for the lakes were developed from topographic maps at a scale of 1:4,800, with a contour interval of two-feet, based on aerial photographs taken of the study area in the fall of 1975 (Aero-Metric Engineering, Inc., 1975). Stage-discharge relationships for the controlling structures on each lake were developed from the MNDOT's design discharge curves and nomographs (Federal Highway Administration, 1965) and weir flow equations and coefficients from Design of Small Dams (U.S. Department of the Interior, 1973). Culvert dimensions and elevations were field surveyed. Starting water-surface elevations of 937 and 932 feet NGVD were used for Dutch Lake and Langdon Lake, respectively. The hydraulic analyses for these areas were based on existing development conditions.

A stage-frequency curve was developed for Lake Minnetonka using the Weibull formula (Chow, V. T., 1969) based on the historic water-surface elevations for the 77 years of record (1897-1904, 1906-1908, 1910-1975). Lake levels for the period 1931 to 1940, inclusive, were not used in the analysis due to a severe drought.

This drought produced extremely low water levels which were inconsistent with the balance of the record.

Starting water-surface elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were based on the normal high-water level of 929.4 feet NGVD established for Lake Minnetonka by the MDNR (MDNR, 1977a).

Wave height analysis in the Cities of Mound and Orono, conducted in accordance with procedures outlined in the U.S. Army Coastal Engineering Research Center, "Shore Protection Manual" (USACE, 1975c), indicates that wave height is not significant on Lake Minnetonka within the Cities of Mound and Orono.

For Medicine Lake, Hadley Lake and the unnamed pond located downstream of Hadley Lake the water-surface elevations of floods of the selected recurrence intervals were computed by considering the runoff volume resulting from a 10-day snowmelt event. The outflow from the lake during the runoff event was based on the rating curve for the outlet as developed using the USACE, HEC computer program, HEC-2 (USACE, 1973c) for Bassett Creek downstream of the lake. The rating curves for the outlet structures for Hadley Lake and the unnamed pond located downstream of Hadley Lake were developed using highway nomographs (Bassett Creek Flood Control Commission, 1972) and weir flow equations.

Pike Lake and Eagle Lake were treated as reservoirs for routing. For Eagle Lake and Pike Lake, the inflow hydrographs were routed in a manner similar to those already explained; however, the rating curve for the Eagle Lake outlet structure, which controls the flood level on Pike Lake, was also determined using weir flow equations and coefficients published by the U.S. Bureau of Reclamation (U.S. Department of the Interior, 1973). The elevations for those streams studied by approximate methods were obtained from the topographic maps provided by the city (Mark Hurd Aerial Surveys, Inc., 1960).

Water-surface elevations for Bush Lake were determined by the hydrologic analysis, as previously described.

Memory Lane, Brownwood, Hagermeister, and Gaulke Ponds were analyzed as an interconnected reservoir problem with unsteady flow. Rating curves were developed for inlet control flow, pressure flow, and overland flow between the ponds. A tabulation computation procedure was used with a computation interval of 1 day to determine the maximum water-surface elevation on the ponds during the 30-day snowmelt runoff event. This procedure was repeated for the 10-, 2-, 1-, and 0.2-percent-annual-chance frequency events. Starting water-surface elevations were assumed at the inverts of the outlet pipes for Memory Lane, Brownwood, and Hagermeister Ponds, while the starting water-surface elevation for Gaulke Pond was determined as the elevation at which the outlet pump is started.

The flood level for Twin Lakes was based on the flood level reported in the “Water Resources Management Plan for Shingle Creek” (Barr Engineering Company, 1974). The flood level for Hanson Pond was approximated by estimating the runoff volume resulting from a 1-percent-annual-chance frequency rainfall event and average outflow. The flood level for Florida Pond was approximated by considering the runoff volume resulting from a spring snowmelt runoff event with consideration of the seepage outflow.

In the City of Wayzata the hydraulic analyses of the approximate studies, the inlet channel to Peavey Lake and the outlet of Hadley Lake, were conducted using the following methods. Hydraulic structure information, representative cross sections, and friction values were obtained by field inspection. Representative water-surface elevations were then obtained using Bernoulli's equation, Manning's equations, weir flow equations, and USGS topographic maps (USGS, various dates).

Cross-section data and roughness coefficients (Manning's "n") for the Crow River were based on field investigations and adjusted to more closely match high water marks. In the Cities of Hanover, Greenfield, and Rogers, cross-section data and roughness coefficients for the main stem Crow River and South Fork Crow River used were developed for the Wright County, Minnesota, FIS (FEMA, 1992f).

For Gleason Creek, in the City of Wayzata, cross-sectional data, hydraulic parameters, and friction values were obtained by field inspection.

All cross sections for Elm Creek and Rush Creek in the City of Dayton were obtained by the SCS, with the exception of sections along U.S. Highways 52 and 169, which were field surveyed by the USGS (SCS, 1975a). For Elm Creek in the City of Medina, cross sections and stream characteristics were obtained from field surveys and aerial topographic maps at a scale of 1:62,500, with a contour interval of twenty-feet (USGS, various dates).

In the City of Edina, cross sections on Minnehaha Creek for the backwater analysis were field surveyed in the reach upstream from the dam at Browndale Avenue. Downstream from the Browndale Avenue dam on Minnehaha Creek, Nine Mile Creek, and Braemer Branch South Fork Nine Mile Creek, overbank data were obtained from new two-foot contour interval topographic maps at a scale of 1:4,800 (Mark Hurd Aerial Surveys, Inc., 1976) and the underwater parts were field surveyed.

In the Cities of Hopkins and Minnetonka, for Minnehaha Creek and Nine Mile Creek, channel alignment and valley cross-section data were obtained using two-foot contour mapping (Minnesota Water Resources Board and Nine Mile Creek Watershed District, 1973) this mapping has been revised to reflect additional hydraulic structures constructed in the floodplain. Cross sections for the backwater analyses were field-surveyed and were located at close intervals above and below bridges and culverts in order to compute significant backwater effects in the developing area, and are shown on the FIRM.

In the Cities of Brooklyn Center and Brooklyn Park, cross sections for the backwater analysis of the Mississippi River were obtained from previous studies (Carlson, G.H., and L.C. Guetzkow, 1980; Carlson, G.H., undated). In the City of Dayton, cross-section data for the Mississippi and Crow Rivers were obtained from aerial photographs; the below water sections were obtained by field measurement.

For the Mississippi River, it was necessary to field survey much of the overbank to supplement the available maps (USACE, 1940). More recent maps along the Mississippi River were available for work maps (Mark Hurd Aerial Surveys, Inc., 1977a; Mark Hurd Aerial Surveys, Inc., 1974a and 1974c; MDNR, 1972). The underwater part of all cross sections, except for the Mississippi River downstream from Lock and Dam 1, and all bridges and culverts were field surveyed to obtain elevation data and structural geometry. Data for that part of the Mississippi River downstream from Lock and Dam 1 were obtained from earlier work by the MDNR (MDNR, 1972). No cross sections were obtained in the reach of the Mississippi River between the two dams at St. Anthony Falls. Velocities during floods are very high in this reach and the banks and structures along the river are subject to severe erosion and damage from ice and debris. The channel is so constricted that any additional encroachment is unreasonable.

Channel alignment and valley cross sections for Nine Mile Creek, Shingle Creek and Ryan Creek were obtained using a 1:4,800 scale, two-foot contour map (City of Hopkins, 1957; Alster and Associates, Inc., 1976a). Due to the age (1956) of the topographic mapping for Nine Mile Creek, the creek alignment was defined by field traverse.

In the City of Independence, cross sections for the backwater analyses of Pioneer Creek and Lake Robina Tributary were obtained from the Flood Hazard Study of Pioneer Creek (SCS, 1979). The profiles generated by the FIS contractor were found to be within 0.5 foot of the Flood Hazard Study Profile, therefore the profiles reported in the "Flood Hazard Study. Pioneer Creek, Spurzem Creek, and Lake Robina Tributary" were used for this report. The overbank portions of the cross sections were obtained from the 1:6,000 scale, two-foot contour interval, topographic maps prepared for the Flood Hazard Study by the SCS (Mark Hurd Aerial Surveys, Inc., 1977b). The channel portions of the cross sections were obtained by field surveys.

For Rush Creek and North Fork Rush Creek, in the City of Corcoran, stream characteristics were determined from field observations, field surveys of the floodplain, roads and bridges, and topographic maps (USGS, various dates; Mark Hurd Aerial Surveys, Inc., 1974a and 1974c).

Maps for Shingle Creek, and Minnehaha Creek were obtained from the city (Mark Hurd Aerial Surveys, Inc., 1974a and 1974c; City of Minneapolis, 1971). Data from these maps were supplemented by transit-stadia surveys to locate planimetric features, update cross-section data, and plot flood outlines where the maps were found to be obsolete.

Overbank cross sections for Shingle Creek, Bass Creek, and Eagle Creek were obtained from detailed topographic maps at a scale of 1:1,200 with two-foot contour intervals (Chicago Aerial Surveys, 1969). Developer's site plans were utilized with supplemental field checking and field surveying to update the topographic information and to delineate flood outlines to reflect current conditions (Olson, DeWayne C., 1976; Westwood Planning and Engineering Company, 1975; Westwood Planning and Engineering Company, 1979; Consulting Engineers Diversified, Inc., 1977; William S. Peterson and Associates, 1978; Miller Hanson Westbeck Bell Architects, Inc., 1978; Bather, Ringrose, Wolsfeld, Inc., 1974; Meadow Corporation, 1976; Hedlund Engineering Services, 1978; Coffin, Gordon R., 1976; Korsunsky, Krank Architects, Inc., 1974; Landmark Planning and Engineering Company, 1974; Suburban Engineering, Inc., 1979). Topographic data (Blumenthals, Architecture, Inc., 1978; Blumenthals, Architecture, Inc., 1979; City of Brooklyn Center, 1978) for very recent developments were utilized to revise the profiles and flood outlines just before completing the report. Underwater portions of the cross sections and all bridges, dams, and culverts were field surveyed to obtain elevation data and structural geometry.

Photogrammetric methods were used to obtain data for the dry portions of the cross sections for Unnamed Tributary to Stubbs Bay. Data for those portions of the cross sections underwater as well as the dimensions and elevations of hydraulic structures were obtained through field survey. Cross sections for the analysis were located at close intervals upstream and downstream of bridges, culverts, and other obstructions in order to compute significant backwater effects of these structures. Other cross sections were located along the watercourse in a manner that would provide a typical representation of the stream valley topography.

There was no hydraulic analysis of Purgatory Creek, per se. Due to the restrictive culverts and subsequent ponding nature of the area, water-surface elevations as obtained from the watershed district engineer and verified by TR-20 watershed model were used for the entire detailed stream reach.

The hydraulic analyses for County Ditch No. 18 Branch F, Crow River, Edinbrook Channel, Elm Creek, Mississippi River, Nine Mile Creek, Plymouth Creek, Purgatory Creek, and Rush Creek were computed using the USACE, HEC computer program, HEC-2 (USACE, 1973c; USACE, 1979). Cross sections were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects at these structures. Locations of selected cross sections used in the hydraulic analysis are shown on the maps. Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

For Bass Creek, the starting water-surface elevations were obtained from a synthetic hydrograph developed from elevation and discharge relationships.

In the City of New Hope, water-surface elevations for Bass Creek are controlled by hydraulic structures located at 62nd Avenue North. The effect of this structure is to create a constant elevation backwater pool extending upstream to County Road 18, the City of New Hope. This backwater pool utilizes existing valley storage. Water-surface profiles resulted from routing through storage elevation curves which were then checked by making head loss computations utilizing Federal Highway Administration hydraulic structure analysis criteria (Federal Highway Administration, 1965). Water-surface elevations for North Branch Bassett Creek are controlled by hydraulic structures located at 36th Avenue North, at the private entrance to apartment buildings, at Winnetka Avenue North, and at Boone Avenue North. The effect of these structures is to create an upstream backwater pool that utilizes existing valley storage. A constant discharge was assumed through each structure.

Water-surface profiles for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were computed using the USACE, HEC computer program, HEC-2 (USACE, 1979). One model was developed for the entire length of the main stem Crow River from its confluence with the Mississippi River to the confluence of North and South Forks. This model is based on the existing models used for Wright County and the City of Rockford (FEMA, 1992e; FIA, 1978d) with revisions to account for the modifications of Hanover Dam and Berning Mill Dam. The profiles from the revised models were compared to those from the existing model, and showed only minor changes in the vicinity of the dams. Starting water-surface elevations used were those used for the Wright County, Minnesota, FIS (FEMA, 1992f), which were derived from an elevation-discharge rating curve from the City of Dayton FIS (FIA, 1978a).

For the Crow River, the computer model was calibrated on the basis of profile points established during the flood of July 1975 and the profile of the 1965 flood (USACE, 1969). Once calibrated, the models were used to compute the various flood-frequency profiles.

The HEC-2 analysis for Edinbrook Channel was done to verify that the 1-percent-annual-chance flood discharge is contained within the channel banks of Edinbrook Channel upstream of the confluence with County Drain No. 5.

For Elm Creek, the flood-frequency profiles were obtained from the SCS. The original SCS data were incomplete in that the profiles terminated at the point where overflow from Mill Pond occurred at Highways 52 and 169. Additional surveys to define overflow sections and an analysis of the amount of overflow were conducted by the USGS and furnished to the SCS. The required adjustments to the profiles were then made by the SCS and furnished for use in this report. Those for Elm Creek were furnished by the SCS (SCS, 1975a).

Shallow flooding is caused in the lower portion of Gleason Creek, downstream of Rice Street, due to the inability of the Rice Street drainage pipe to carry the flood flows of Gleason Creek. Depths in the shallow flooding area were determined using Manning's equation assuming normal depth.

Flood profiles and Shingle Creek were started using normal depth analysis near the mouth. Data at the southern corporate limit of the City of Minneapolis on the Mississippi River are from another study, and rating curves with extensions for the headwater pools at Lock and Dam 1 and Upper St. Anthony Falls gave starting elevations at those locations (MDNR, 1972).

The Minnesota River hydraulic analysis was determined by the USGS for the City of Bloomington Type 15 FIS (FIA, 1981a).

For the Mississippi River, water-surface elevations floods of the selected recurrence intervals were computed using the USACE, HEC computer program, HEC-2 (USACE, 1979).

The Mississippi River flood profiles were computed in a continuous reach from the Third Avenue bridge in the City of Minneapolis to Coon Rapids Dam and started again upstream from the dam using an elevation-discharge rating curve developed from data collected during the 1965 flood (Carlson, G.H., and L.C. Guetzkow, 1980; Carlson, G.H., undated). A model had been developed for the Mississippi River from the Coon Rapids Dam, 7 miles downstream from Dayton, through the City of Dayton, and for 15 miles upstream (USGS, 1973). Analyses of the hydraulic characteristics of the Mississippi River from the Coon Rapids Dam upstream through the City of Champlin, and Elm Creek were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

This model was calibrated by adjustment to reproduce established profile points for the 1965 flood (USGS, 1970b; USACE, 1973a; Northern States Power Company, 1973; City Commission of Anoka, 1966) which crested at approximately the same elevation as the 1-percent-annual-chance flood through the City of Dayton. Flood profiles through the reach of the Mississippi River between the two dams at St. Anthony Falls are based on high water data from past floods. Shallow flooding occurs at the Upper St. Anthony Falls Dam. The 1-percent-annual-chance flood passes through openings and low points in the wall above the powerhouse and flows down a steep incline in a sheet, about one-foot deep. This was determined through direct observation by engineers at the hydraulics laboratory during the 1965 floods. An anomalous situation occurs at Upper St. Anthony Falls Dam, where the 1-percent-annual-chance flood flow bypasses a weir above the powerhouse and sheets down a steep slope.

The computer model for the Mississippi River was calibrated on the basis of documented data from the 1965 flood (USGS, undated; USGS, 1968). For the Mississippi River, roughness coefficients were adjusted so that computed profiles would match the defined profiles of the 1965 (which crested approximately 0.8 foot below the 1-percent-annual-chance flood in the study reach) and 1969 floods when using the corresponding peak discharges. Adjustments to the "n" values were made as required to match the known elevations for this flood, which was only slightly lower than the 1-percent-annual-chance flood.

Water-surface profiles for the various frequency floods on Purgatory Creek, and Minnehaha Creek were computed using the USACE, HEC computer program, HEC-2 (USACE, 1973c).

For Shingle Creek, flood profiles were computed as a continuous reach beginning at the mouth at the Mississippi River in the City of Minneapolis and continuing upstream through the Cities of Minneapolis, Brooklyn Center, and Brooklyn Park for FISs of the adjacent communities (FIA, 1981b); thus, the profile is continuous at the four locations where Shingle Creek crosses the border of the City of Brooklyn Center. Water-surface elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods were determined using the USACE, HEC computer program, HEC-2 (USACE, 1973c).

In the City of Plymouth, along Plymouth Creek, the water-surface elevations of floods of the selected recurrence intervals were computed through the use of the USACE, HEC computer program, HEC-2 (USACE, 1973c). Cross sections and channel crossing inverts and dimensions were field surveyed. Supplemental cross-section data were taken from the topographic maps provided by the city (Mark Hurd Aerial Surveys, Inc., 1960). Cross sections for step-backwater analysis were located at close intervals above and below bridges and culverts in order to compute the significant backwater effects of these structures in an urbanizing area.

The step-backwater computations were started downstream of the confluence of Pioneer Creek and the South Fork Crow River. The starting elevations and additional cross sections for the South Fork Crow River were obtained from the adjoining Wright County FIS (FEMA, 1992f).

Starting water-surface elevations for Bassett Creek-Sweeney Lake Branch were obtained from an analysis prepared from the USACE 1976 Flood Control Feasibility Study (USACE, 1976). Water-surface elevations in the temporary storage areas at the time of greatest inflow, as calculated by the USACE, HEC computer program, HEC-1, were used for the starting water-surface elevations (USACE, 1973b). Due to restrictive hydraulic structures, the entire stream reach was reservoir routed. Reservoir-routing for this reach was prepared utilizing discharge-storage-elevation relationships supplied by the Flood Control Commission Engineer and verified by the study contractor.

Starting water-surface elevations for the main stem Crow River model were those used for the Wright County, Minnesota, FIS, which were derived from an elevation-discharge rating curve from the City of Dayton (FEMA, 1992c). Starting water-surface elevations for the South Fork model were derived from elevations computed at the upstream limits of the main stem model. The profiles for the revised models were compared with those from the existing models, and showed no significant changes in the vicinity of the City of Greenfield.

Hydraulic analyses including starting water-surface elevations, for Elm Creek in the City of Medina, were made by the SCS and the Hennepin Soil and Water Conservation District as part of a previous flood hazard study (SCS, 1975b). Roughness coefficients (Manning's "n") were assigned on the basis of field inspection. Water-surface profiles were developed using the USACE, HEC computer program, HEC-2 (USACE, 1973c). The starting water-surface elevation used for Gleason Creek was the 10-percent-annual-chance flood level for Lake Minnetonka (FIA, 1978c). Water-surface elevations for Gleason Creek were computed using the USACE, HEC computer program, HEC-2 (USACE, 1979). This computer program models the physical and hydraulic parameters of a man-made or natural waterway.

Starting water-surface elevations for Minnehaha Creek were taken from the FIS for the City of Minneapolis at the City of Edina corporate limits (FIA, 1980d).

A model was developed for South Fork Crow River from the confluence of North and South Forks to the upstream corporate limits of the City of Watertown, in Carver County. The main stem model is based on existing models for the Wright County and City of Rockford, FISs, with revisions to account for the modification of Hanover Dam and Berning Mill Dam. The South Fork model is based on the Wright County model and on a model provided by the MDNR for a portion of South Fork in Carver County, including the City of Watertown.

Starting water-surface elevations for the Mississippi River were taken from a study for the MDNR at the pool above Upper St. Anthony Falls (Carlson, G.H., and L.C. Guetzkow, 1980; Carlson, G.H., undated). In that study, the rating curves for the headwater pools at Upper Anthony Falls determined the starting water-surface elevations.

Starting elevations Elm Creek at the dam were developed using data obtained by the Northern States Power Company during the flood of 1965 (Northern States Power Company, 1973). Starting water-surface elevations were obtained from a stage-discharge relationship developed for the pool at the Coon Rapids Dam, for the condition of the gates being wide open. Water-surface profiles were then computed for floods of the selected recurrence intervals.

Starting water-surface elevations for Nine Mile Creek and Braemer Branch South Fork Nine Mile Creek were determined by the slope/area method. Water-surface elevations of floods of the selected recurrence intervals were computed through use of the USACE, HEC computer program, HEC-2 (USACE, 1973c).

The starting water-surface elevation for Nine Mile Creek was determined by a normal depth analysis, in the City of Bloomington, for a surveyed cross section located downstream from the detailed study limits.

Starting water-surface elevations for Rush Creek and North Fork Rush Creek used in the SCS Flood Hazard Analysis were based on the 1-percent-annual-chance flood elevation of the Mississippi River (SCS, 1975a; U.S. Department of Agriculture and Hennepin Soil and Water Conservation District, 1977). Water-surface profiles were computed using the USACE, HEC computer program, HEC-2 (USACE, 1973c).

Starting water-surface elevations for Shingle Creek were obtained by normal depth analysis near the mouth.

In the City of Orono, the water-surface elevations for the selected recurrence intervals for the Unnamed Tributary to Stubb's Bay were computed utilizing the USACE, HEC computer program, HEC-2 (USACE, 1973c).

Flood profiles were drawn showing the computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

Computations for the flood profiles were made assuming full hydraulic efficiency of the stream channels and structures without consideration for the effects of obstructions. Obstructions caused by ice jams or debris, primarily on Elm Creek, can cause flooding in local areas, but the magnitude and frequency of occurrence of such flooding is unpredictable. The flood elevations as shown on the profiles, therefore, are considered valid only if the hydraulic structures remain unobstructed and function according to design.

Areas of the Rockford, protected by levees along the Crow River are subject to potential risk due to possible failure or overtopping of the levee. These areas were delineated by applying the 1-percent-annual-chance elevation determined from the "levee in place" analysis and 0.2-percent-annual-chance elevation determined from the "without levee" analysis.

French Lake, Diamond Lake, Diamond Creek, and several smaller streams studied by approximate methods were delineated using engineering judgment and field inspection, aerial photographs (U.S. Agricultural Stabilization and Conservation Service, 1969) and topographic maps (USGS, various dates). Goose Lake and several smaller lakes and swampy areas were also studied by approximate methods.

The approximate 1-percent-annual-chance elevations for Dutch Lake and Landgon Lake were determined using culvert nomographs (Federal Highway Administration, 1965), USGS Flood-Prone Area Maps (USGS, various dates), and a field investigation of the study area.

The approximate studies in the City of Orono were based on USGS topographic maps (USGS, various dates), culvert nomographs (Federal Highway Administration, 1965), and field investigations.

The approximate study areas are associated with the development "envelopes" for the area shown in the overall plan (Minnesota Water Resources Board and Nine Mile Creek Watershed District, 1973). The "envelopes" were developed from rating curve analysis done at all the bridge crossings and culverts. The geometries of the culverts were taken from two-foot contour interval maps and field survey. The flood boundary delineations were made on the two-foot contour interval topographic maps obtained from the city.

The approximate study of Bassett Creek-Sweeney Lake Branch was conducted using normal depth calculations.

For lakes and ponding areas studied by approximate methods, the 1-percent-annual-chance flood elevations (based on the highest levels observed since 1963) were estimated using field inspection, engineering judgment, and topographic maps (Mark Hurd Aerial Surveys, Inc., 1976; Johnson, H. S., 1974).

All areas studied by approximate methods were taken from the SCS report Landscape for Hennepin County (SCS, 1976). Various soils types were located, and their boundaries were transferred onto the FIRM. This methodology was reviewed and accepted by the FIA.

The 1-percent-annual-chance flood elevation for flood-prone areas studied by approximate methods was obtained by using topographic maps, aerial photographs, field inspection, and engineering judgment to locate where upland and swampland separate (Chicago Aerial Surveys, 1969; USGS, various dates; U.S. Agricultural Stabilization and Conservation Service, 1969).

Manning's "n" values for Nine Mile Creek were determined by field inspection using criteria outlined in the USGS Water Supply Paper No. 1849, the SCS National Engineering Handbook, and Gray's Handbook of Hydrology (USGS, 1967; SCS, 1975b; Gray, Donald M., 1970).

Channel roughness factors (Manning's "n") used in the hydraulic computations for bridges and other channel obstructions and channel were chosen by engineering judgment, based on field observations inspections, examination of aerial photographs and topographic maps (USGS, various dates; Hennepin County

Highway Department, 1978; MCWD, 1973). The "n" values were then calculated through analysis of high water marks from prior flood events of the streams and floodplain areas. The "n" values were then calculated through analysis of high water marks from prior flood events.

Manning's "n" values used for the backwater computations along Elm Creek and Rush Creek were assigned on the basis of field inspection of floodplain areas by the SCS (SCS, 1975a).

Flood-prone areas studied by approximate methods were delineated using topographic maps (Alster and Associates, Inc., 1976a; USGS, 1967), aerial photographs (Alster and Associates, Inc., 1976b), field inspection, and engineering judgment.

Flood elevations in the Cities of Crystal, Mound, Maple Grove, Orono, and Plymouth can be raised by debris accumulations at hydraulic structures; however, the hydraulic analysis of this study was based only on the effects of unobstructed flow. The flood elevations, as reported, are thus considered valid only if hydraulic structures, in general, remain unobstructed, operate properly, and do not fail. Likewise, changes in the sizes or elevations of existing culverts or other hydraulic structures could greatly affect the existing flood conditions.

Flood profiles showing computed water-surface elevations for the selected recurrence intervals are shown in Exhibit 1.

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Survey data used in the restudy of Bassett Creek and North Branch Bassett Creek were obtained from various sources. Dry parts of cross sections were generally taken from available topography. The main stem of Bassett Creek from the conduit inlet to about Highway 55 (Sta. 80+07 to 163+81), was taken mainly from City of Minneapolis 1"=100' scale, two-foot contour interval topography based on aerial photography flown in 1961 and 1967. This topography is still acceptable since this portion of the channel has not changed much and the controls for flood elevation are generally at numerous crossings. For the main stem from County Road 18 to Medicine Lake (Sta. 597+51 to 675+79) 1975 field survey data were used. Cross sections for the North Branch Bassett Creek were field surveyed in 1975.

Channel shape and invert elevations of wet portions of the channel from the conduit inlet to Golden Valley Road (Sta. 80+07 to 238+00) were based on cross sections field surveyed mainly in the 1960s, with some surveyed in 1979 and 1980. Channel and overbank lengths were measured on the 1"=100' scale topographic maps. Channel width, invert and distance between cross sections from Golden Valley Road to Highway 55 (Sta. 238+00 to 545+20) were obtained from stream thalweg maps field surveyed in 1979. From Highway 55 to County Road 18 (Sta. 545+20 to 597+51) channel widths were measured from 1"=100' topographic maps and inverts were estimated using the channel inverts at the Highway 55, Boone Avenue, and County Road 18 crossings. Bridge and culvert opening data was obtained by field surveys in 1963, 1973, 1975, 1979, and 1980.

The channel was modeled using the July 1979 and April 1980 revisions of the November 1976 versions of the USACE, HEC computer program, HEC-2.

Discharges used in the HEC-2 backwater analysis were obtained from the HEC-1 results. In some locations, peak stages and peak discharges did not coincide due to backwater effects.

Hydraulic information was utilized from the analysis performed for the "Flood Control, Bassett Creek Watershed, Hennepin County, Minnesota No. 1, Hydrologic and Hydraulic" as published by the USACE, St. Paul District (USACE, 1981).

Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

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Floodplain areas of the Lower Minnesota River were revised for this revision. The hydraulic modeling effort began with converting the existing HEC-2 models to HEC-RAS. Because the 1-percent-annual-chance flood profile developed as part of the USGS report, "Flood Plain Areas of the Mississippi River", represents the "base" flood profile (the profile used to assess the effect of the floodway), base-flood conditions were recreated in the HEC-RAS model (USGS, 1973). This involved removing the Interstate 494 bridge, the new Cedar Avenue bridge, and a number of fill areas along the south side of the Minnesota River between the Cedar Avenue bridge and Shakopee. Creating base-flood conditions also involved including the now removed railroad bridge just downstream of State Highway 41. The limits of effective flow were set based on conditions that existed in the spring of 1972 (the 1973 report used conditions in the spring of 1972 as "base" conditions). After recreating the base-flood conditions model, an existing conditions HEC-RAS model was developed. The new bridges and fill areas were added to the model and the railroad bridge just down stream of State Highway 41. The limits of effective flow were adjusted appropriately to account for these changes. The USGS and USACE identified areas with significant changes in vegetation since the spring of 1972 and used that information to adjust the existing condition model's Manning's "n" values. In some areas the changes in vegetation have increased the profile slightly, while in other areas the changes have decreased the profile slightly.

The calibration of the base-flood-conditions model focused on reproducing the 1969 flood high water marks. The existing conditions model was calibrated to the 1993, 1997, and 2001 flood high water marks.

The starting-water surface elevations were estimated using the recently revised Mississippi River HEC-2 model, which was used to produce the St. Paul FIS (FEMA, 1989). The HEC-2 model was used to determine the difference in water surface elevation between the recorded tailwater at Lock and Dam No. 1 and the mouth of the Minnesota River for Mississippi River flows occurring at the time of the peak Minnesota River flows.

The effective Minnesota River HEC-2 model was obtained and converted to a HEC-RAS model. The converted HEC-RAS model was found to match the published elevations. The model was modified to include two additional cross sections in the vicinity of the City of Bloomington. It was necessary to insert additional cross sections to demonstrate that the existing profiles would not be affected in this reach and to compute a revised floodway.

For Braemer Branch, Braemer Branch (Split Flow), Nine Mile Creek (County Ditch 34), Nine Mile Creek (Main Stem), Nine Mile Creek (North Branch), and Nine Mile Creek (South Branch), water-surface elevations were computed using XP-SWMM, version 10.6. A known value was used as the starting water-surface elevation.

A portion of Crow River was revised in the reach known as North Point. The purpose of the analysis was to correctly delineate the 1-percent-annual-chance flood boundary in this reach and to demonstrate that the existing buildings in this reach are not located in the floodway.

The City of Rogers provided a copy of a detailed topographic map for North Point. The topography was developed by photogrammetric methods from aerial photographs taken in April 1985. The topographic map was developed prior to the construction of buildings near the floodway and prior to the existing FIS. The effective HEC-2 model was obtained and converted to a HEC-RAS model. The converted HEC-RAS model was found to match the published elevations. The model was next modified to include two additional cross sections in North Point. It was necessary to insert additional cross sections to demonstrate that the existing profiles would not be affected in the vicinity of North Point and to compute a revised floodway.

For Minnehaha Creek, water-surface elevations were computed using XP-SWMM, version 10.0. Existing HEC-2 models were used as the basis for cross-sections used in the model. However, field surveys were also used to acquire data immediately upstream and downstream of structures.

Manning's "n" values used in the hydraulic computations were chosen by engineering judgment and were based on field observations of the streams and floodplain areas. Manning’s "n" for all streams studied by detailed methods are shown in Table 8.

Table 8 – Manning's "n" Values

Stream	Channel "n"	Overbank "n"
Bass Creek	0.035-0.045	0.045-0.075
Bassett Creek	*	*
Bassett Creek – Sweeney Lake Branch	*	*
Braemer Branch	0.030-0.060	0.010-0.050
Braemer Branch (Split Flow)	0.030-0.060	0.010-0.050
Century Channel	*	*
Crow River	0.030-0.055	0.040-0.150
Eagle Creek	*	*
East Channel Bassett Creek	*	*
East Channel Mississippi River	*	*
Elm Creek	0.040-0.100	0.040-0.140
Gleason Creek	0.025-0.120	0.030-0.140
Lake Robina Tributary	0.035-0.080	0.050-0.120
Long Lake Creek	*	*
Minnehaha Creek	0.030-0.050	0.060-0.100
Minnesota River	0.038-0.042	0.028-0.150
Mississippi River	0.022-0.034	0.036-0.150
Nine Mile Creek (County Ditch 34)	0.030-0.060	0.010-0.050
Nine Mile Creek (Main Stem)	0.030-0.060	0.010-0.050
Nine Mile Creek (North Branch)	0.030-0.060	0.010-0.050
Nine Mile Creek (South Branch)	0.030-0.060	0.010-0.050
North Branch Bassett Creek	*	*
North Fork Rush Creek	0.040	0.120
Painter Creek	*	*
Pioneer Creek	0.035-0.080	0.050-0.120
Plymouth Creek	0.012-0.120	*
Rush Creek	0.040-0.071	0.070-0.140
Shingle Creek	0.015-0.055	0.035-0.100
Six Mile Creek	*	*
South Fork Crow River	0.030	0.045-0.120
Unnamed Tributary	0.025-0.100	0.025-0.100
Unnamed Tributary to Stubbs Bay	*	*

*Data not available

3.3 Vertical Datum

All FISs and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum in use for newly created or revised FISs and FIRMs was the NGVD. With the finalization of the North American Vertical Datum of 1988 (NAVD), many FIS reports and FIRMs are being prepared using NAVD as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to NGVD. Structure and ground elevations in the county must, therefore, be referenced to NGVD. It is important to note that adjacent counties may be referenced to NAVD. This may result in differences in base flood elevations across the county boundaries between the counties.

For more information on NAVD, see "Converting the National Flood Insurance Program to the North American Vertical Datum of 1988", FEMA Publication FIA-

20/June 1992, or contact the Vertical Network Branch, National Geodetic Survey, Coast and Geodetic Survey, National Oceanic and Atmospheric Administration, Rockville, Maryland 20910 (Internet address: http://www.ngs.noaa.gov).

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. Therefore, each FIS provides 1-percent-annual-chance (100-year) flood elevations and delineations of the 1- and 0.2-percent-annual-chance (500-year) floodplain boundaries and 1-percent-annual-chance floodway to assist communities in developing floodplain management measures. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data Table, and Summary of Stillwater Elevations Table. Users should reference the data presented in the FIS report as well as additional information that may be available at the local map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1- percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the county.

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For the streams studied in detail, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using topographic maps and aerial photographs at scales of 1:24,000 and 1:6,000 with a contour interval of ten-feet, and scales of 1:7,200, 1:6,000, 1:4,800, 1:2,400 and 1:1,200 with a contour interval of two-feet (Aero-Metric Engineering, Inc., 1975; Public Works of Bloomington, 1973; USGS, 1976; Chicago Aerial Surveys, 1965 and 1973; 1969; Olson, DeWayne C., 1976; Westwood Planning and Engineering Company, 1975; Westwood Planning and Engineering Company, 1979; Bather, Ringrose, Wolsfeld, Inc., 1974; Meadow Corporation, 1976; Hedlund Engineering Services, 1978; Coffin, Gordon R., 1976; Korsunsky, Krank Architects, Inc., 1974; Landmark Planning and Engineering Company, 1974; Suburban Engineering, Inc., 1979; Alster and Associates, 1976a; USGS, 1967; MDNR, 1973a; Orr-Schelen-Mayeron and Associates, Inc., 1966 and 1967; SCS, 1975a; Johnson, H. S., 1974; USGS, various dates; SCS, 1974; Mark Hurd Aerial Surveys, Inc., 1960; 1974a; 1974b; 1976; 1977b; City of Minneapolis, 1971; City of Minnetonka, 1973; MCWD, 1973; City of Golden Valley, 1976; City of Hopkins, 1957; USGS, 1981).

Boundaries of the 1- and 0.2-percent-annual-chance floods were delineated by photogrammetric means and using aerial photographs (Mark Hurd Aerial Surveys, Inc., 1975; Aero-Metric Engineering, Inc., 1977). To improve the accuracy of the flood boundary delineations, additional water-surface elevations were computed between cross sections to supplement those already determined at cross sections.

For areas located between the cross sections, the flood boundaries were determined by interpolation from adjacent elevations using the existing two-foot contour interval mapping (MCWD, 1973) and using the Flood Hazard Boundary Map (FIA, 1978). This delineation was checked by field inspection of the area.

For this countywide FIS, between cross sections, the boundaries were interpolated using topographic maps at scale of 1:100 with a contour interval of two-feet (USACE, 1981).

Approximate flood boundaries were taken from three previous SCS reports: a Flood Hazard Study. Pioneer Creek, Svurzem Creek, Lake Robina Tributary (SCS, 1979); a Flood Hazard Analysis; Elm and Rush Creeks (SCS, 1975a); and a Soil Survey of Hennepin County, Minnesota (SCS, 1974). Approximate flood boundary delineation from the first two reports were transferred directly to the FIRMs. The approximate flood boundaries from the third report were delineated using SCS soil classifications and sound engineering judgment. This methodology was reviewed and accepted by the FIA.

Approximate flood boundaries were also interpolated using topographic maps taken from the previously printed FIS reports, FHBMs, and/or FIRMs for all of the incorporated and unincorporated jurisdictions within Hennepin County (Chicago Aerial Surveys, 1965 and 1973; McCombs Frank Roos Associates, Inc., 1992; Alster and Associates, Inc., 1976a; MDNR, 1973a; USGS, various dates; Johnson, H. S., 1974) and using the SCS, Landscape for Hennepin County (SCS, 1976). Various soils types were located and their boundaries were transferred onto the FIRMs. This methodology was reviewed and accepted by the FIA. The SCS soil survey has superseded the published Flood Hazard Boundary Map (FIA, 1978).

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For the Crow River, the 1- and 0.2-percent-annual-chance floodplain boundaries were delineated using the flood elevations determined at each cross section. Between cross sections in the area known as North Point, the boundaries were interpolated using maps provided by the City of Rogers, with a contour interval of two-feet (City of Rogers, 1985).

For the Minnehaha Creek watershed, the 1- and 0.2-percent-annual-chance floodplain boundaries were delineated using digital LiDAR topography (Aero-Metric Engineering, Inc., 2008) and existing topography provided by the City of Minneapolis (City of Minneapolis, 1971). Each topographic data source had a two-foot contour interval.

For the Nine Mile Creek watershed, the 1-percent-annual-chance floodplain boundaries were delineated using two-foot contour interval topography provided by the communities (Chicago Aerial Survey, 1965 and 1973; Chicago Aerial Surveys, 1969).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. The 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AE, AH, and AO), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only 1-percent-annual-chance floodplain boundary is shown on the FIRM.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 1-percent-annual-chance flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies. In Minnesota, however, floodplain encroachment is limited by Minnesota Regulations to that which would cause a 0.5-foot increase in flood heights above pre-floodway conditions at any point (MDNR, 1977c). Floodways having no more than 0.5-foot surcharge were delineated for this FIS. The floodway can be adopted directly or can be used as a basis for additional floodway studies.

The floodways presented in this FIS report and on the FIRM were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations have been tabulated for selected cross sections in Table 9. In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary has been shown.

No floodway was determined for the reach of Elm Creek extending upstream from U.S. Highway 169. In this reach, little encroachment is possible, as the stream is bordered by steep banks or right-ofway for U.S. Highway 169. The city has no jurisdiction within the right-ofway of the highway. Encroachment to the limit of the channel banks would have virtually no effect on the 1-percent-annual-chance flood elevation.

The floodway for the Mississippi River was delineated based on exclusion of nonconveyance flow areas.

Shingle Creek flows into the marsh surrounding Palmer Lake at the downstream corporate limits; therefore, the 1-percent-annual-chance flood elevation on the lake, with no surcharge added, was used as the starting water-surface elevation for the floodway computations for Shingle Creek. The floodway for Shingle Creek and Bass Creek was delineated based on engineering judgement and effective flow areas. No floodway was depicted for Shingle Creek from the Burlington Northern Railroad to the north exit ramp of Interstate Highway 94, and in the vicinity of Palmer Lake due to impoundment effects.

The floodway for Minnehaha Creek is an administrative floodway. The effective floodway was maintained as closely as possible. For locations where the effective floodway was outside of the new floodplain, the effective floodway was shifted or reduced. Additionally, areas designated as storage areas in the model were mapped as floodway.

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
BRAEMER BRANCH								
A	1,990	*	*	*	842.6	842.6	*	*
B	2,352	*	*	*	842.6	842.6	*	*
C	4,436	*	*	*	850.0	850.0	*	*
D	4,746	*	*	*	852.3	852.3	*	*
E	5,905	*	*	*	860.0	860.0	*	*
F	6,689	*	*	*	860.6	860.6	*	*
G	6,919	*	*	*	860.7	860.7	*	*
H	7,035	*	*	*	861.0	861.0	*	*
BRAEMER BRANCH (SPLIT FLOW)								
A	860	*	*	*	833.5	833.5	*	*
B	2,418	*	*	*	839.3	839.3	*	*
C	3,616	*	*	*	842.3	842.3	*	*
D	4,239	*	*	*	844.9	844.9	*	*

[1]Feet above confluence with Nine Mile Creek (South Branch)
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

BRAEMER BRANCH –
BRAEMER BRANCH (SPLIT FLOW)

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
MINNEHAHA CREEK								
A	2,495	*	*	*	715.2	714.4[2]	*	*
B	2,525	*	*	*	715.2	714.6[2]	*	*
C	4,140	*	*	*	744.0	744.0	*	*
D	4,153	*	*	*	745.0	745.0	*	*
E	4,864	*	*	*	808.6	808.6	*	*
F	4,894	*	*	*	808.6	808.6	*	*
G	8,854	*	*	*	813.8	813.8	*	*
H	9,495	*	*	*	813.9	813.9	*	*
I	10,449	*	*	*	814.7	814.7	*	*
J	10,808	*	*	*	815.0	815.0	*	*
K	15,320	*	*	*	818.5	818.5	*	*
L	15,479	*	*	*	818.6	818.6	*	*
M	17,005	*	*	*	820.6	820.6	*	*
N	17,505	*	*	*	820.8	820.8	*	*
O	18,599	*	*	*	822.9	822.9	*	*
P	19,546	*	*	*	823.7	823.7	*	*
Q	21,074	*	*	*	824.4	824.4	*	*
R	21,424	*	*	*	824.7	824.7	*	*
S	21,974	*	*	*	825.3	825.3	*	*
T	22,188	*	*	*	825.5	825.5	*	*

[1]Feet above confluence with Mississippi River
[2]Elevation computed without consideration of backwater effects from Mississippi River
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

MINNEHAHA CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
MINNEHAHA CREEK (CONTINUED)								
U	24,595	*	*	*	829.4	829.4	*	*
V	25,157	*	*	*	829.9	829.9	*	*
W	26,421	*	*	*	832.5	832.5	*	*
X	26,604	*	*	*	832.9	832.9	*	*
Y	28,106	*	*	*	835.5	835.5	*	*
Z	28,539	*	*	*	836.0	836.0	*	*
AA	29,211	*	*	*	837.1	837.1	*	*
AB	29,619	*	*	*	837.3	837.3	*	*
AC	35,757	*	*	*	844.7	844.7	*	*
AD	35,857	*	*	*	844.7	844.7	*	*
AE	37,399	*	*	*	845.8	845.8	*	*
AF	37,456	*	*	*	846.0	846.0	*	*
AG	38,122	*	*	*	846.5	846.5	*	*
AH	38,177	*	*	*	846.6	846.6	*	*
AI	39,601	*	*	*	849.1	849.1	*	*
AJ	40,167	*	*	*	850.2	850.2	*	*
AK	41,419	*	*	*	851.6	851.6	*	*
AL	41,980	*	*	*	852.0	852.0	*	*
AM	47,197	*	*	*	861.1	861.1	*	*
AN	48,089	*	*	*	861.3	861.3	*	*

[1]Feet above confluence with Mississippi River
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

MINNEHAHA CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
MINNEHAHA CREEK (CONTINUED)								
AO	49,339	*	*	*	862.3	862.3	*	*
AP	49,989	*	*	*	862.8	862.8	*	*
AQ	51,269	*	*	*	864.8	864.8	*	*
AR	51,301	*	*	*	864.8	864.8	*	*
AS	52,258	*	*	*	865.7	865.7	*	*
AT	52,752	*	*	*	866.1	866.1	*	*
AU	55,437	*	*	*	871.3	871.3	*	*
AV	55,972	*	*	*	872.5	872.5	*	*
AW	57,062	*	*	*	877.9	877.9	*	*
AX	57,072	*	*	*	878.0	878.0	*	*
AY	61,063	*	*	*	889.6	889.6	*	*
AZ	61,090	*	*	*	889.6	889.6	*	*
BA	62,081	*	*	*	889.8	889.8	*	*
BB	62,527	*	*	*	890.2	890.2	*	*
BC	74,643	*	*	*	891.8	891.8	*	*
BD	74,686	*	*	*	892.0	892.0	*	*
BE	75,804	*	*	*	897.3	897.3	*	*
BF	76,342	*	*	*	898.3	898.3	*	*
BG	77,614	*	*	*	900.7	900.7	*	*
BH	77,794	*	*	*	901.1	901.1	*	*

[1]Feet above confluence with Mississippi River
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

MINNEHAHA CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
MINNEHAHA CREEK (CONTINUED)								
BI	80,923	*	*	*	902.7	902.7	*	*
BJ	81,085	*	*	*	903.0	903.0	*	*
BK	81,413	*	*	*	903.4	903.4	*	*
BL	81,727	*	*	*	903.7	903.7	*	*
BM	87,899	*	*	*	905.9	905.9	*	*
BN	92,294	*	*	*	907.5	907.5	*	*
BO	94,911	*	*	*	911.4	911.4	*	*
BP	94,981	*	*	*	911.4	911.4	*	*
BQ	97,162	*	*	*	915.1	915.1	*	*
BR	97,167	*	*	*	915.1	915.1	*	*
BS	99,578	*	*	*	916.2	916.2	*	*
BT	99,820	*	*	*	916.7	916.7	*	*
BU	102,871	*	*	*	921.9	921.9	*	*
BV	103,153	*	*	*	922.2	922.2	*	*
BW	104,562	*	*	*	928.4	928.4	*	*
BX	105,127	*	*	*	929.5	929.5	*	*
BY	105,587	*	*	*	930.2	930.2	*	*
BZ	106,032	*	*	*	930.5	930.5	*	*

[1]Feet above confluence with Mississippi River
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

MINNEHAHA CREEK

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
NINE MILE CREEK (COUNTY DITCH 34)								
A	1,330	*	*	*	852.9	852.9	*	*
B	4,941	*	*	*	865.6	865.6	*	*
C	5,444	*	*	*	865.7	865.7	*	*
D	6,799	*	*	*	875.1	875.1	*	*
E	7,407	*	*	*	875.2	875.2	*	*
F	9,026	*	*	*	881.5	881.5	*	*
G	9,643	*	*	*	884.5	884.5	*	*
H	10,338	*	*	*	891.3	891.3	*	*
I	10,663	*	*	*	891.8	891.8	*	*
J	11,465	*	*	*	899.1	899.1	*	*
K	11,729	*	*	*	899.2	899.2	*	*
L	12,215	*	*	*	899.8	899.8	*	*
M	14,374	*	*	*	904.5	904.5	*	*

[1]Feet above confluence with Nine Mile Creek (South Branch)
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

NINE MILE CREEK (COUNTY DITCH 34)

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
NINE MILE CREEK (MAIN STEM)								
A	7,477	*	*	*	716.0	708.2[2]	*	*
B	9,487	*	*	*	716.0	710.2[2]	*	*
C	10,733	*	*	*	717.3	717.3	*	*
D	13,382	*	*	*	731.7	731.7	*	*
E	13,392	*	*	*	733.3	733.3	*	*
F	13,434	*	*	*	734.1	734.1	*	*
G	13,876	*	*	*	736.0	736.0	*	*
H	14,845	*	*	*	744.7	744.7	*	*
I	15,759	*	*	*	753.4	753.4	*	*
J	16,416	*	*	*	755.5	755.5	*	*
K	18,151	*	*	*	765.2	765.2	*	*
L	18,161	*	*	*	766.6	766.6	*	*
M	20,605	*	*	*	784.2	784.2	*	*
N	22,507	*	*	*	788.3	788.3	*	*
O	23,207	*	*	*	790.2	790.2	*	*
P	23,570	*	*	*	790.5	790.5	*	*
Q	24,173	*	*	*	796.5	796.5	*	*
R	24,294	*	*	*	796.6	796.6	*	*
S	25,159	*	*	*	797.0	797.0	*	*
T	25,611	*	*	*	797.0	797.0	*	*

[1]Feet above confluence with Minnesota River
[2]Elevation computed without consideration of backwater effects from Minnesota River
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

NINE MILE CREEK (MAIN STEM)

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
NINE MILE CREEK (MAIN STEM) (CONTINUED)								
U	27,154	*	*	*	797.1	797.1	*	*
V	27,682	*	*	*	797.2	797.2	*	*
W	28,699	*	*	*	799.2	799.2	*	*
X	28,928	*	*	*	799.4	799.4	*	*
Y	30,221	*	*	*	800.3	800.3	*	*
Z	30,563	*	*	*	800.4	800.4	*	*
AA	35,939	*	*	*	804.1	804.1	*	*
AB	40,006	*	*	*	804.3	804.3	*	*
AC	44,659	*	*	*	812.4	812.4	*	*
AD	48,356	*	*	*	812.6	812.6	*	*

[1]Feet above confluence with Minnesota River
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

NINE MILE CREEK (MAIN STEM)

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
NINE MILE CREEK (NORTH BRANCH)								
A	2,648	*	*	*	814.7	814.7	*	*
B	2,690	*	*	*	815.4	815.4	*	*
C	4,650	*	*	*	819.5	819.5	*	*
D	5,189	*	*	*	820.0	820.0	*	*
E	7,550	*	*	*	824.0	824.0	*	*
F	8,208	*	*	*	824.6	824.6	*	*
G	9,654	*	*	*	825.7	825.7	*	*
H	10,282	*	*	*	826.8	826.8	*	*
I	12,627	*	*	*	837.7	837.7	*	*
J	12,809	*	*	*	837.7	837.7	*	*
K	13,786	*	*	*	844.2	844.2	*	*
L	16,575	*	*	*	845.8	845.8	*	*
M	18,116	*	*	*	847.6	847.6	*	*
N	18,619	*	*	*	848.1	848.1	*	*
O	19,084	*	*	*	851.0	851.0	*	*
P	23,536	*	*	*	851.4	851.4	*	*
Q	24,226	*	*	*	856.7	856.7	*	*
R	24,634	*	*	*	856.7	856.7	*	*
S	26,260	*	*	*	857.3	857.3	*	*
T	26,913	*	*	*	857.7	857.7	*	*

[1]Feet above convergence with Nine Mile Creek (Main Stem)
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

NINE MILE CREEK (NORTH BRANCH)

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
NINE MILE CREEK (NORTH BRANCH) (CONTINUED)								
U	27,095	*	*	*	860.2	860.2	*	*
V	27,136	*	*	*	860.3	860.3	*	*
W	27,812	*	*	*	865.2	865.2	*	*
X	29,815	*	*	*	867.0	867.0	*	*
Y	31,977	*	*	*	872.1	872.1	*	*
Z	32,345	*	*	*	872.5	872.5	*	*
AA	37,602	*	*	*	877.7	877.7	*	*
AB	38,141	*	*	*	878.2	878.2	*	*
AC	40,253	*	*	*	888.3	888.3	*	*
AD	40,358	*	*	*	888.4	888.4	*	*
AE	40,818	*	*	*	891.4	891.4	*	*
AF	40,925	*	*	*	891.6	891.6	*	*
AG	41,546	*	*	*	894.2	894.2	*	*
AH	41,632	*	*	*	894.3	894.3	*	*
AI	41,954	*	*	*	896.8	896.8	*	*
AJ	42,293	*	*	*	896.9	896.9	*	*
AK	42,583	*	*	*	900.1	900.1	*	*
AL	42,625	*	*	*	900.2	900.2	*	*

[1]Feet above convergence with Nine Mile Creek (Main Stem)

*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

NINE MILE CREEK (NORTH BRANCH)

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
NINE MILE CREEK (SOUTH BRANCH)								
A	2,353	*	*	*	814.1	814.1	*	*
B	2,741	*	*	*	814.1	814.1	*	*
C	7,341	*	*	*	824.5	824.5	*	*
D	8,785	*	*	*	825.0	825.0	*	*
E	9,662	*	*	*	832.6	832.6	*	*
F	10,315	*	*	*	832.6	832.6	*	*
G	11,654	*	*	*	832.7	832.7	*	*
H	12,374	*	*	*	832.7	832.7	*	*
I	12,892	*	*	*	832.7	832.7	*	*
J	14,220	*	*	*	832.7	832.7	*	*
K	16,201	*	*	*	833.8	833.8	*	*
L	16,729	*	*	*	833.8	833.8	*	*
M	17,589	*	*	*	834.1	834.1	*	*
N	17,990	*	*	*	834.1	834.1	*	*
O	22,422	*	*	*	839.4	839.4	*	*
P	22,668	*	*	*	839.5	839.5	*	*
Q	23,170	*	*	*	840.0	840.0	*	*
R	23,851	*	*	*	840.1	840.1	*	*
S	24,854	*	*	*	842.3	842.3	*	*
T	25,461	*	*	*	842.4	842.4	*	*

[1]Feet above convergence with Nine Mile Creek (Main Stem)

*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

NINE MILE CREEK (SOUTH BRANCH)

FLOODING SOURCE		FLOODWAY			1-PERCENT-ANNUAL-CHANCE-FLOOD WATER SURFACE ELEVATION			
NODE	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (FEET NGVD)	WITHOUT FLOODWAY (FEET NGVD)	WITH FLOODWAY (FEET NGVD)	INCREASE (FEET)
NINE MILE CREEK (SOUTH BRANCH) (CONTINUED)								
U	28,102	*	*	*	849.9	849.9	*	*
V	28,301	*	*	*	849.9	849.9	*	*
W	29,144	*	*	*	852.9	852.9	*	*
X	36,900	*	*	*	861.7	861.7	*	*
Y	37,507	*	*	*	866.5	866.5	*	*
Z	38,211	*	*	*	874.8	874.8	*	*
AA	39,354	*	*	*	884.0	884.0	*	*
AB	41,267	*	*	*	890.9	890.9	*	*
AC	41,581	*	*	*	892.2	892.2	*	*
AD	41,961	*	*	*	892.4	892.4	*	*
AE	42,947	*	*	*	896.0	896.0	*	*
AF	43,867	*	*	*	896.7	896.7	*	*
AG	45,648	*	*	*	898.4	898.4	*	*
AH	46,306	*	*	*	899.8	899.8	*	*

[1]Feet above convergence with Nine Mile Creek (Main Stem)
*Data not available – Administrative Floodway

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

FLOODWAY DATA

NINE MILE CREEK (SOUTH BRANCH)

Data was not available for the effective floodways for Braemer Branch, Braemer Branch (Split Flow), Nine Mile Creek (County Ditch 34), Nine Mile Creek (Main Stem), Nine Mile Creek (North Branch), and Nine Mile Creek (South Branch). Therefore, in the interest of maintaining the current level of regulation, these floodways are depicted on the FIRM as administrative floodways.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 1-percent-annual-chance flood by more than 1.0 foot (0.5 foot in Minnesota) at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 1.

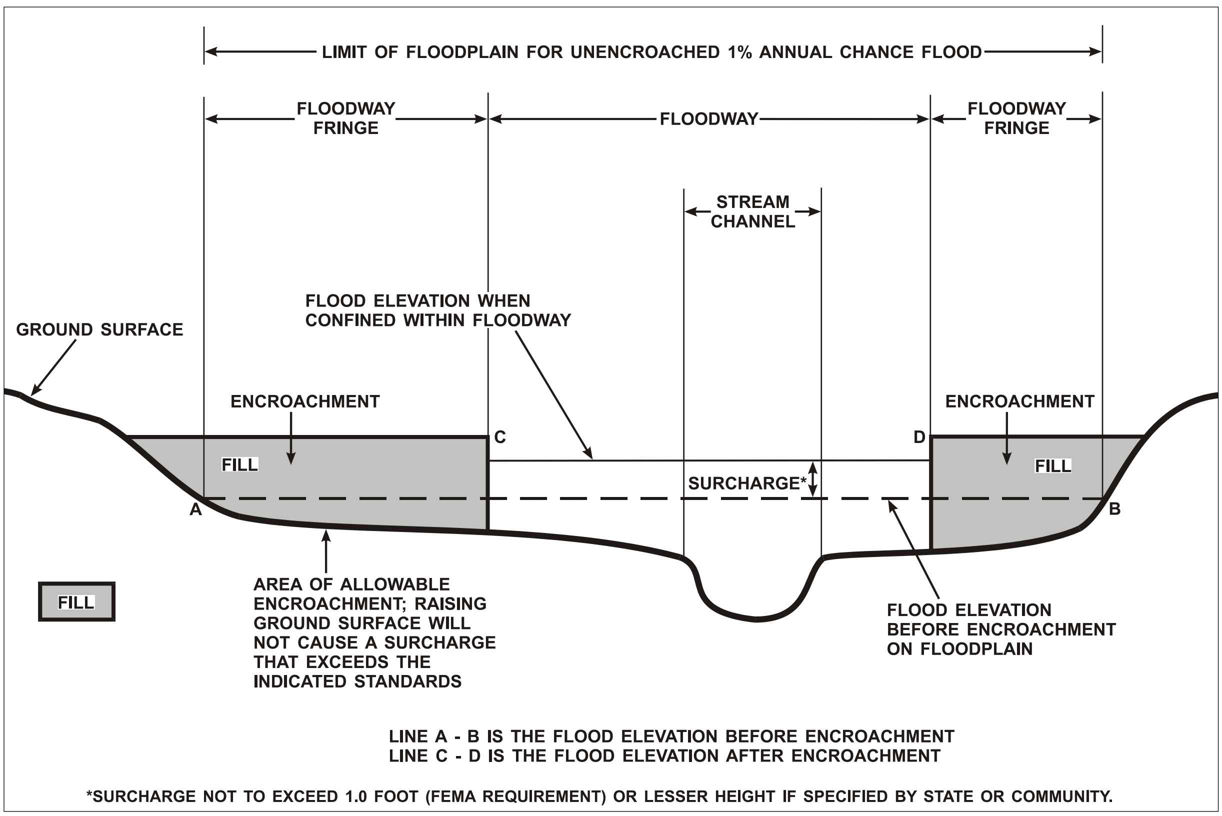

Figure 1 – Floodway Schematic

Portions of the floodway widths for the Crow River, Mississippi River, Minnesota River, and South Fork Crow River extend beyond the county boundary.

No floodways were computed for Bassett Creek – Sweeney Lake Branch, Century Channel, Eagle Creek, East Channel Bassett Creek, East Channel Mississippi River, Gleason Creek, Long Lake Creek, Painter Creek, Six Mile Creek, and Unnamed Tributary.

5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. The zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, 1 whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year floodplain, areas within the 500-year floodplain, and to areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance risk zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use the zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The current FIRM presents flooding information for the entire geographic area of Hennepin County. Previously, separate Flood Hazard Boundary Maps and/or FIRMs were prepared for each identified flood-prone incorporated community and the unincorporated areas of the county. This countywide FIRM also includes flood hazard information that was presented separately on Flood Boundary and Floodway Maps, where applicable. Historical data relating to the maps prepared for each community, up to and including this countywide FIS, are presented in Table 10.

7.0 OTHER STUDIES

Barr Engineering Company prepared several reports affecting the City of Bloomington. One report is the Nine Mile Creek Watershed District Overall Plan (Minnesota Water Resources Board and Nine Mile Creek Watershed District, 1973). The flood profiles and floodplain delineation shown in this report are based on ultimate watershed development. Improvements assumed in the development of these profiles include impoundment structures, capacity of increased hydraulic structures and the complete urbanization of the watershed.

A "Hydrological Study of Hyland-Bush-Anderson Lakes" was prepared in 1971 (Barr Engineering Company, 1971). This study details existing hydraulic and hydrologic information for the study lakes and includes water quality information and a discussion as to minimum lake elevations during drought conditions. This study goes on to recommend an outlet structure and lake level augmentation schemes; i.e., pumping. Neither has occurred to date and the prognosis for installation of the recommendations is uncertain. The data contained in the report were utilized during the TR-20 watershed analysis prepared by Edwards and Kelcey.

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Bloomington, City of	September 12, 1972	None	September 8, 1972	July 1, 1974 March 12, 1976 September 16, 1981
Brooklyn Center, City of	November 9, 1973	July 9, 1976	February 17, 1982	None
Brooklyn Park, City of	April 12, 1974	July 25, 1975	May 17, 1982	December 15, 1983 September 30, 1995
Champlin, City of	November 22, 1973	None	July 18, 1977	None
*Chanhassen, City of	N/A	None	N/A	None
Corcoran, City of	June 7, 1974	May 28, 1976 May 20, 1977	January 16, 1981	None
Crystal, City of	November 30, 1973	June 4, 1976	June 1, 1978	November 19, 1986
Dayton, City of	January 4, 1974	October 15, 1976	February 1, 1978	August 18, 1992
Deephaven, City of	September 2, 2004	April 4, 1975	September 2, 2004	None
Eden Prairie, City of	March 1, 1974	September 26, 1975	September 27, 1985	January 17, 1986
Edina, City of	February 1, 1974	July 25, 1975	May 1, 1980	None
Excelsior, City of	May 31, 1974	July 30, 1976	December 1, 1977	December 21, 1979 March 20, 1981

*No special flood hazard areas identified

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
Golden Valley, City of	March 8, 1974	April 30, 1976	February 4, 1981	August 19, 1986
Greenfield, City of	December 7, 1973	April 16, 1976	April 15, 1981	August 18, 1992
Greenwood, City of	September 2, 2004	None	September 2, 2004	None
Hanover, City of	November 23, 1973	June 4, 1976	May 5, 1981	May 4, 1989 August 3, 1992
Hopkins, City of	November 9, 1973	May 7, 1976	May 5, 1981	June 16, 1992
Independence, City of	June 28, 1974	July 30, 1976	January 6, 1983	September 30, 1992
Long Lake, City of	September 2, 2004	None	September 2, 2004	None
Loretto, City of	January 24, 1975	None	September 2, 2004	None
Maple Grove, City of	March 22, 1974	September 24, 1976	April 17, 1978	None
Maple Plain, City of	September 2, 2004	None	September 2, 2004	None
Medicine Lake, City of	December 17, 1976	None	April 15, 1982	None
Medina, City of	June 28, 1974	September 26, 1975	September 3, 1980	None
Minneapolis, City of	March 22, 1974	April 30, 1976	February 18, 1981	None
Minnetonka, City of	August 23, 1974	July 23, 1976	May 19, 1981	September 30, 1992

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
The Village of Minnetonka Beach, City of	September 2, 2004	None	September 2, 2004	None
Minnetrista, City of	January 13, 1978	None	September 27, 1985	None
Mound, City of	June 7, 1974	May 7, 1976	September 29, 1978	None
New Hope, City of	September 6, 1974	July 11, 1975	January 2, 1981	None
Orono, City of	August 16, 1974	October 17, 1975 December 3, 1976	October 17, 1978	None
*Osseo, City of	N/A	None	N/A	None
Plymouth, City of	February 8, 1974	March 19, 1976	May 15, 1978	February 19, 1982
Richfield, City of	September 2, 2004	None	September 2, 2004	None
Robbinsdale, City of	March 29, 1974	February 13, 1976	August 1, 1977	None
Rockford, City of	November 9, 1973	February 13, 1976	November 1, 1979	August 18, 1992
Rogers, City of[1]	February 10, 1978	None	March 16, 1981	June 16, 1993
Shorewood, City of	May 31, 1974	March 19, 1976	December 4, 1979	July 2, 1982
Spring Park, City of	June 7, 1974	November 21, 1975	May 1, 1979	None

*No special flood hazard areas identified
[1]Dates for the City of Rogers are taken from the Township of Hassan

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISION DATE	FIRM EFFECTIVE DATE	FIRM REVISION DATE
*St. Anthony, City of	N/A	None	N/A	None
St. Bonifacius, City of	September 2, 2004	None	September 2, 2004	None
St. Louis Park, City of	May 25, 1973	None	June 1, 1977	June 17, 1986
Tonka Bay, City of	June 7, 1974	March 19, 1976	May 1, 1979	None
Wayzata, City of	June 21, 1974	March 19, 1976	November 1, 1979	June 11, 1982
Woodland, City of	May 31, 1974	October 24, 1975	August 1, 1979	January 6, 1982

*No special flood hazard areas identified

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

HENNEPIN COUNTY, MN
(ALL JURISDICTIONS)

COMMUNITY MAP HISTORY

A “Natural Ordinary High Water Investigation for Anderson Lakes” was performed in 1973 (MDNR, 1973b). This report was based on field examination of the lake shore. The natural ordinary high water mark is coordinated with the upper limit of the lake and is determined by examination of the bed and banks of the lake to ascertain where the presence and action of water has occurred for a sufficient length of time to leave upon the ground a line with respect to the character of vegetation or the soil or both. The natural ordinary high water elevation given in the report is elevation 839.0 NGVD and a 0.2-percent-annual-chance flood elevation of 838.4 NGVD as accepted by the Inter-Agency Review Committee.

The “Feasibility of Mount Normandale Lake and Marsh Lake” includes design studies for the Marsh Lake impoundment structure based on ultimate watershed development (Barr Engineering Company, 1967).

A preliminary report, “Projected Study and Report on the Bassett Creek Watershed” (Orr-Schelen, Inc., 1961), detailing the stormwater drainage problems in the watershed and developing a plan to provide protection from a 10-percent-annual-chance storm was prepared by a consulting engineering firm in 1961 (USACE, 1976). The report recommended storage sites and channel improvements throughout the watershed to provide that protection.

The "Bassett Creek Watershed Hydrology Existing Land Use" report (USACE, 1980) contains discharge information for Bassett Creek, and flood elevations for Medicine Lake.

The USACE, St. Paul District prepared a Feasibility Report for Flood Control, Bassett Creek Watershed in March 1976 (USACE, 1976) which contains flood level information for Bassett Creek and North Branch Bassett Creek, Medicine Lake, and Plymouth Creek. Changes to the watershed have occurred which were not considered in the development of the 1-percent-annual-chance profiles. This report contains flood elevation information for Bassett Creek and Medicine Lake. One of the profiles in the feasibility report is labeled existing 1-percent-annual-chance flood. These existing profiles are for in-place channel and hydraulic structures based on the hydrologic analysis assuming that the watershed is in a state of ultimate urbanization.

The USGS was contacted to obtain flow information. The information provided consists of streamflow data collected at a partial-record station on the North Branch of Bassett Creek for the years 1963 to 1974. This information appears in the annual publication titled “Water Resources Data for Minnesota, Part 1, Surface Water Records” (USGS, 1963-1974).

A Watershed Management Plan for Bassett Creek was prepared and adopted by the Bassett Creek Flood Control Commission in May 1972 (USACE, 1976; City of Golden Valley, 1972). The report contains hydrologic and hydraulic information on Bassett Creek, North Branch Bassett Creek, Plymouth Creek, Medicine Lake, Rice Lake, and Grimes Avenue Pond. The plan delineated the 1-percent-annual-chance floodplain and established a "management envelope" or elevation below which future development would be restricted. The management of this "envelope" will preserve the various options available for flood control until a plan which meets the needs of the public can be implemented. The plan was based on ultimate watershed development and includes proposed hydrologic and hydraulic changes which do not, at this time, exist. Further, watershed changes have occurred which were not considered in the development of the profiles and floodplain delineations.

A Water Resources Management Plan for Shingle Creek, which includes Bass Creek, was prepared in 1974 by Barr Engineering Company (Barr Engineering Company, 1977). The basic purpose of this plan is to identify the potential assets and problems concerning the water resources of Shingle Creek and its tributaries. Studies of the watershed assumed ultimate development conditions and development of a significant amount of additional storage within the watershed. The plan includes 1-percent-annual-chance elevations for Twin Lakes based on existing development conditions and includes 1-percent-annual-chance elevations for Bass Lake and Bass Creek based on existing development conditions. The information contained in this management plan has been used to define the approximate 1-percent-annual-chance flood boundaries for Twin Lakes.

Flood hazard analyses have been published by the SCS for Elm and Rush Creeks (SCS, 1975a) and North Fork Rush Creek (U.S. Department of Agriculture and Hennepin Soil and Water Conservation Service, 1977). This report contains a 1-percent-annual-chance flood profile and outline for Elm Creek based on existing development conditions. The information contained in the Flood Hazard Analysis has been used to define the approximate 1-percent-annual-chance flood boundaries for Elm Creek and its tributaries in this study. The hydrologic analyses for Elm and Rush Creeks, Fish Lake, and Rice Lake from the SCS report were used in this study.

The 1975 “Engineers Annual Report” was also prepared by Barr Engineering Company (Barr Engineering Company, 1976). The data in this report documents present conditions within the watershed and summarizes historical data.

For the Mississippi River, a Floodplain Information report (USACE, 1971) had been prepared that was superseded by “Flood Plain Areas of the Mississippi River Study” (Carlson, G. H., undated).

The USGS, in cooperation with the MDNR, has completed a Floodplain Study of the Mississippi River, in the Cities of Champlin and Dayton and adjacent areas (USGS, 1973; MDNR, 1973a).

The flood profiles and floodplain delineations shown in the Nine Mile Creek Watershed Plan for Bassett Creek (Bassett Creek Flood Control Commission, 1972), are based on ultimate watershed development. Improvements assumed during development of hydraulics/hydrology include impoundment structures, increased capacity of hydraulic structures, and the complete urbanization of the watershed.

The Hennepin Soil and Water Conservation District published the “Flood Hazard Study, Pioneer Creek, Spurzem Creek, and Lake Robina Tributary” (SCS, 1979).

The Hennepin County Highway Department prepared hydrologic studies for crossings of County Road 18 and both study streams (Barr Engineering Company, 1977).

Eugene A. Hickock and Associates prepared a surface water management plan for the City of Orono (City of Orono, 1974). The study delineates drainage areas in the city and presents the results of a hydrologic analysis of these watershed areas. The hydrologic analysis conducted for the surface water management plan is based on the maximum density of future development which could be anticipated from a review of existing land use plans.

The report, "Storm Drainage Plan, Plymouth, Minnesota" (City of Plymouth, 1973), contains a 1-percent-annual-chance flood profile for Bassett Creek, Medicine Lake, and Plymouth Creek. The profiles in the Drainage Plan are based on the profile expected as a result of storm drainage improvements proposed in the Drainage Plan, including storm sewer improvements and additions, modified channel crossing structures, and temporary inundation storage ponds.

Information pertaining to revised and unrevised flood hazards for each jurisdiction within Hennepin County has been compiled into this FIS. Therefore, this FIS supersedes all previously printed FIS Reports, FHBMs, FBFMs, and FIRMs for all of the incorporated and unincorporated jurisdictions within Hennepin County.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting FEMA, Federal Insurance and Mitigation Division, 536 South Clark Street, Sixth Floor, Chicago, Illinois 60605.

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