FLOOD-PLAIN AREAS OF THE LOWER MINNESOTA RIVER

This document was prepared in 2004 by the U.S. Army Corps of Engineers (USACE) and the U.S. Geological Survey (USGS). Upon the appropriate review, the information contained in this report may be used as "best available data" until the Federal Emergency Management Agency (FEMA) produces new Flood Insurance Study (FIS) maps for the affected communities.

Study Area

The study area extends approximately 36 river miles from the mouth of the Minnesota River upstream to about four river miles upstream of Carver, Minnesota. It is essentially the same study area as found in the 1973 USGS report titled "Flood-plain Areas of the Lower Minnesota River".

Hydrology

In October 2001 the USACE produced the report "Section 22 Study: Minnesota River Main Stem Hydrologic Analysis". 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) are used for the entire study reach. The old and new discharge-frequency information is provided in Table 1.

Table 1: Adopted Discharge-Frequency Values for USGS Gage 05330000 near Jordan, Minnesota

	Peak Discharge (cfs) for Exceedence Frequency (%)			
	10%	2%	1%	0.2%
Values Prior to 2001	48,400	91,400	115,000	182,000
Current Values Adopted in 2001	48,500	85,300	103,000	148,000

Hydraulics

The hydraulic modeling effort began with converting the existing HEC-2 models into HEC-RAS. Next, because the 100-yr flood profile developed as part of the 1973 study represents the "base" flood profile (the profile used to assess the impact of the floodway), base flood conditions were recreated in the HEC-RAS model. 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 at Chaska. 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). The recreated base flood profile is within 0.1 ft of the 100-yr profile published in the 1973 report except between cross-sections 22 and 50, where it is up to 0.3 ft lower. The recreated base flood conditions model was not adjusted to better match the 1973 profile between cross-sections 22 and 50 because of what was learned during the calibration effort. This will be described in a following paragraph.

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 downstream of State Highway 41 at Chaska was removed. The limits of effective flow were adjusted appropriately to account for these changes. The existing conditions model also includes updated channel topography from USACE sounding data (cross-sections 1 – 42) and updated channel and overbank topography from USGS surveys conducted in 2000 (cross-sections 43-91). 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 roughness coefficients (Manning's n values).

The calibration effort involved getting the base flood conditions model to generally reproduce the 1969 flood high water marks and getting the existing conditions model to reproduce the 1993, 1997, and 2001 flood high water marks. The 1973 report indicates that flood-plain changes between the flood of 1969 and the spring of 1972 would have increased the 1969 flood elevations nearly 0.5 ft in Savage. With the base flood conditions model calibrated to be 0.5 ft higher than the 1969 high water marks in and just upstream of Savage, the existing conditions model was noticeably (0.3 to 0.5 ft) higher than the 1993, 1997, and 2001 high water marks. Therefore, the models were adjusted so that the base flood conditions model is only 0.2 to 0.3 ft higher than the 1969 high water marks in and just upstream of Savage. This resulted in a base flood conditions model that produces a slightly lower profile between cross-sections 22 and 50 than what was published in the 1973 report. The base flood conditions model was not calibrated to the 1965 flood due to changes that occurred in the Minnesota River flood-plain between the 1965 and 1969 floods. The most significant change was the placement of fill that inhibited flow over the south approach of the Interstate 35W bridge. This issue is also discussed in the 1973 report.

The 1969, 1993, 1997, and 2001 flood discharges and starting water surface elevations used in the calibration effort are provided in Table 2. The discharge used is the peak flood discharge reported at USGS Gage 05330000 near Jordan, Minnesota. The starting water surface elevation were estimated using the recently revised St. Paul FIS Mississippi River HEC-2 model 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 the Mississippi River flows occurring at the time of the peak Minnesota River flows.

Table 2: Calibration Discharge and Starting Water Surface Elevation Data

Flood Event	Discharge (cfs)	SWSEL (ft, NGVD29)
1969 Flood	84,600	714.2
1993 Flood	92,200	706.0
1997 Flood	82,300	711.5
2001 Flood	87,100	710.9

The 1969, 1993, 1997, and 2001 flood high water marks and the HEC-RAS generated profiles for these flood events are shown below in Figure 1.

For both the base flood conditions model and the existing conditions model, Manning's n values were assigned as indicated in Table 3.

Table 3: Manning's n Values Assigned to Type of Vegetative Cover

Channel - includes vegetation above water to top of bank (cross-sections 1 - 85)	0.042
Channel - includes vegetation above water to top of bank (cross-sections 86 - 91)	0.038
Highway embankment	0.028
Open area without brush/trees	0.055
Open area with some brush/trees	0.065
Urban developed	0.070
Trees with some open area	0.10
Dense trees	0.15

The profiles for the 10%, 2%, 1%, and 0.2% annual exceedence probability events (commonly referred to as the 10-yr, 50-yr, 100-yr, and 500-yr floods, respectively) were determined using the existing conditions model and the revised hydrology. As done for the 1973 report, coincident frequency was assumed to determine the starting water surface elevations (e.g. the 100-yr elevation of the Mississippi River at the mouth of the Minnesota River was used as the starting water surface elevation for the 100-yr flood profile of the Minnesota River). The Mississippi River hydrology has also been updated since the 1973 report. The changes, shown in Table 4, mean that the starting water surface elevations for the Minnesota River profiles also need to change.

Table 4: Adopted Discharge-Frequency Values for USGS Gage 05331000 in St. Paul, Minnesota

	Peak Discharge (cfs) for Exceedence Frequency (%)			
	10%	2%	1%	0.2%
Values in 1973 Report	80,000	133,000	160,000	Not Provided
Current Values	83,000	130,000	150,000	203,000

The results of the St. Paul FIS Mississippi River HEC-2 model at the mouth of the Minnesota River (cross-section 135) were used to get the starting water surface elevations, which are shown in Table 5. The 10,000 cfs reduction in the 100-yr discharge on the Mississippi River results in about a 1.1 ft lower 100-yr flood starting water surface elevation on the Minnesota River.

Table 5: Starting Water Surface Elevations for Minnesota River Profiles

Flood Event	SWSEL (ft, NGVD29)
10-yr	704.83
50-yr	710.96
100-yr	713.32
100-yr Floodway	713.55
500-yr	719.08

The existing conditions profiles for the 10-yr, 50-yr, 100-yr, and 500-yr floods are provided in Figure 2. The 1973 base flood profile is also shown in this figure for the purpose of comparison. The floodway follows the currently published floodway with minor changes to accommodate existing development and to remove a couple of small areas obviously outside the limits of effective flow. As was the case for the 1973 report, the floodway is set at the 100-yr flood-plain boundary for much of the study area. Because of the reduction in the 100-yr flood profile due to the reduction in the 100-yr discharges on the Mississippi River and the Minnesota River, the floodway stage increase is assessed against a revised base flood profile generated by using the base flood conditions geometry and the current 100-yr discharge and starting water surface elevation for the Minnesota River. The stage increase caused by the floodway is tabulated in Table 6. The stage increase does not exceed the State of Minnesota's 0.5 ft criteria.

The 100-yr flood-plain, the 500-yr flood-plain, and the floodway are delineated on Plates 2 –10. The plates also show the HEC-RAS cross-sections, the location of the "historic" river mile markers shown in the 1973 report, and certified levees. It should be noted that the x-axes of Figures 1 and 2 represent the distance in miles upstream of the Minnesota River mouth measured along the centerline established for this study. Due to

changes in the channel centerline and more accurate tools for measuring the distance along a curved line, this distance does not necessarily coincide with what you would get using the historic river mile markers. 2-ft contours obtained from the City of Bloomington, City of Chaska, Dakota County, and Scott County were used to delineate the 100-yr and 500-yr flood-plains in those communities. Outside of these communities, the 2-ft contours of the 1973 report were used to delineate the 100-yr and 500-yr flood-plains. The underlying photos for Plates 2 – 10 are the publicly available natural color orthophotos collected by U.S. Department of Agriculture's Farm Service Agency in 2003.

Table 6: Floodway Stage Increases (Elevation data is in NGVD29 datum)

XS #	Revised Base Flood	Existing Conditions 100-yr with Floodway	Fldwy Stage Increase	XS #	Revised Base Flood	Existing Conditions 100-yr with Floodway	Fldwy Stage Increase	XS #	Revised Base Flood	Existing Conditions 100-yr with Floodway	Fldwy Stage Increase
1	713.22	713.55	0.33	26	715.79	716.11	0.32	57	720.19	720.47	0.28
2	713.34	713.70	0.36	27	716.14	716.37	0.23	58	720.37	720.64	0.27
3	713.48	713.84	0.36	28	716.33	716.51	0.18	59	720.45	720.72	0.27
4	713.64	713.98	0.34	29	716.43	716.63	0.20	59.5	720.50	720.77	0.27
5	713.77	714.09	0.32	30	716.57	716.77	0.20	60	720.55	720.81	0.26
6.1	713.85	714.19	0.34	31	716.77	716.99	0.22	61	720.60	720.86	0.26
6.5	713.88	714.24	0.36	32	716.97	717.25	0.28	63	720.66	720.92	0.26
6.7	713.91	714.25	0.34	33	717.07	717.34	0.27	64	720.74	720.99	0.25
7.1	713.96	714.31	0.35	34	717.19	717.46	0.27	65	720.97	721.20	0.23
8	714.04	714.39	0.35	35	717.28	717.56	0.28	66	721.23	721.44	0.21
9	714.13	714.47	0.34	36	717.50	717.76	0.26	67	721.34	721.55	0.21
10	714.18	714.52	0.34	37	717.53	717.81	0.28	68	721.41	721.63	0.22
11	714.22	714.56	0.34	39	718.33	718.52	0.19	69	721.50	721.71	0.21
12	714.26	714.59	0.33	40	718.33	718.53	0.20	70	721.69	721.89	0.20
12.3	714.27	714.61	0.34	41	718.70	718.77	0.07	71	721.74	721.98	0.24
12.7	714.28	714.62	0.34	42	718.68	718.87	0.19	73	721.99	722.14	0.15
13.2	714.28	714.61	0.33	43	718.94	719.05	0.11	74	722.35	722.50	0.15
13.4	714.29	714.63	0.34	44	719.08	719.37	0.29	75	722.47	722.61	0.14
14	714.35	714.75	0.40	45	719.16	719.47	0.31	77	722.60	722.74	0.14
15	714.37	714.77	0.40	46	719.26	719.57	0.31	78	722.79	722.93	0.14
16	714.41	714.81	0.40	47	719.32	719.63	0.31	79	722.84	722.98	0.14
17	714.47	714.86	0.39	47.5	719.34	719.65	0.31	80	722.88	723.02	0.14
18	714.54	714.93	0.39	48	719.36	719.66	0.30	81	722.93	723.07	0.14
18.4	714.55	714.94	0.39	48.5	719.46	719.77	0.31	82	722.95	723.09	0.14
19	714.63	715.02	0.39	49	719.49	719.80	0.31	83	723.00	723.14	0.14
20	714.74	715.12	0.38	50	719.53	719.84	0.31	85	723.10	723.23	0.13
21	714.82	715.20	0.38	50.5	719.60	719.90	0.30	86	723.27	723.39	0.12
22	714.88	715.25	0.37	51	719.70	720.01	0.31	87	723.29	723.42	0.13
22.5	714.92	715.28	0.36	52	719.75	720.05	0.30	88	723.53	723.64	0.11
23	714.85	715.22	0.37	53	719.87	720.17	0.30	89	723.70	723.80	0.10
23.5	714.93	715.29	0.36	54	719.95	720.25	0.30	90	723.83	723.91	0.08
23.7	715.06	715.41	0.35	55	720.00	720.30	0.30	91	723.89	723.97	0.08
25	715.19	715.55	0.36	56	720.08	720.38	0.30				