BSDMS Summary Report

82 Highway 25 over Minnesota River at Belle Plaine, MN

Site Location:

Site ID: 82

Site Name: Highway 25 over Minnesota River at Belle Plaine, MN

County: Scott

Nearest City: Belle Plaine

State: MN

Latitude: 443802

Longitude: 934558

USGS Station ID:

Route Number: 25

Route Class: State

Service Level: Mainline

Route Direction: NA

Highway Mile Point:

Stream Name: Minnesota River

River Mile:

Contact:

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Publication:

Site Description:

The study site is located on the Minnesota River .7 miles north of the town of Belle Plaine on State Highway 25. The site is approximately 7.5 miles upstream from the USGS gaging station near Jordan (05330000) and 12 miles downstream from the USGS gaging station at Henderson (33032001). The period of record for the Jordan station is from October 1935 to the current year, with an annual mean flow of 4425 cfs, and an instantaneous peak flow of 117,000 cfs recorded on April 11, 1965. The USGS measured a discharge of 73,200 cfs and significant abutment and contraction scour at the site during real-time bridge scour measurments during the flood in April of 2001.

The structure number for this site is 5260. The Minnesota Dept of Transportation (MnDOT) built the current bridge in 1934. The channel bottom at the time of construction was at approx. the same elevation as the top of footings (elev 695'). Eventually, the channel was scoured well below the footing bottoms, requiring restablization of the channel bed around the piers and left abutment with rip-rap due to a flood in April of 1951 that caused extinsive scouring of the channel. An underwater inspection was completed in 1991and 2000. The 2000 inspection report contained upstream and downstream bridge face profiles which reflected streambed elevations had been returned to levels similar to the initial construction conditions. Both inspections revealed the piers to be in generally good structural condition. Debris buildup at the piers appears to be a recurring problem, especially at pier 1.

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Structure #5260 is a metal truss bridge consisting of 3-150' continuous I-beam spans supported by two concrete column piers with partial web walls, and vertical abutments with wingwalls. The piers and the abutments are founded on piling; the pier piling is driven to an elevation of 637 - 667 ft, and the abutment piling is driven to an elevation of 665-670 ft. Both abutments are set back about 30-40 feet from the top of the channel banks.

Several measurements of scour have occurred at this site, by MnDOT and Collins Engineers, Inc. Collins Engineers, Inc. preformed a series of investigations on the highway 25 bridge in the mid to late 1990's and found the bridge to be in good condition with minor scour depressions at the upstream end of pier #2.

The USGS revisited the site in October 2001 to conduct a post-flood survey and noted that both abutments had been re-stablized and lined with riprap as a result of the damage induced by the April 2001 flood.

Elevation Reference

Datum: MSL

MSL (ft):

Description of Reference Elevation:

The water-surface elevation was measured from the left upstream (north) abutment corner via a tapedown. The elevation of the tapedown location was determined by inspection of the bridge plans to be 736.96 feet above sea level. The surveyed water-surface elevations were also based on the elevation of the north abutment corner, 736.96 ft.

Stream Data

Drainage Area (sq mi):	16010	**Floodplain Width:**	Narrow
Slope in Vicinity(ft/ft):	.000063	**Natural Levees:**	
Flow Impact:	Left	**Apparent Incision:**	
Channel Evolution	Premodifies	**Channel Boundary:**	Alluvial
Armoring:	Unknown	**Banks Tree Cover:**	Medium
Debris Frequency:	Occasional	**Sinuosity:**	Meandering
Debris Effect:	Local	**Braiding:**	None
Stream Size:	Medium	**Anabranching:**	None
Flow Habit:	Perennial	**Bars:**	Narrow
Bed Material:	Sand	**Stream Width Variability:**	Equiwidth
Valley Setting:	Low		

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Roughness Data

Manning's n Values

	Left Overbank	Channel	Right Overbank
High:		0.05	
Typical	0.08	0.025	0.08
Low:			

Bed Material

Measurement Number	Yr	Mo	Dy	Sampler	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)	SP	Shape	Cohesion
1				USGS BM-54H Sampler	0.5	0.5	0.36	0.25			Non-Cohesive
2				USGS BM-54H Sampler	0.07	0.05	0.01				Unknown
3				USGS BM-54H Sampler	0.13	0.09	0.03				Mildly
4				USGS BM-54 Sampler	0.12	0.08	0.03				Mildly

Bed Material Comments

Measurement No: 1

150 ft upstream of bridge in middle of the approach channel, 3 samples collected from boat during low-flow at depth ~ 5 ft.
Results:

Size (mm)	8	4	2	1	.5	.25	.125	.062
% < than	100	100	100	99.8	95.6	16.3	0.5	.2

Measurement No: 2

150 ft downstream of bridge in middle of the exit section, 3 samples collected from boat during low-flow at depth ~ 27.5 ft.
Results:

Size (mm)	8	4	2	1	.5	.25	.125	.062	.016	.004	.002
% < than	100	100	100	100	99.8	99.7	98.6	92.4	58.0	35.8	30.6

Measurement No: 3

3 samples collected in the scour hole at the upstream left abutment in the bridge opening at a depth ~ 24 ft.
Results:

Size (mm)	8	4	2	1	.5	.25	.125	.062	.016	.004	.002
% < than	100	100	100	99.9	99.9	99.8	95.2	75.7	39.2	24.6	20.1

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Measurement No: 4

3 samples collected in the scour hole in the upstream left bank scour hole at a depth ~ 12 ft.
Results:

Size (mm)	8	4	2	1	.5	.25	.125	.062	.016	.004	.002
% < than	100	100	100	99.9	99.7	99.4	95.7	78.5	40.5	23.6	19.0

Bridge Data

Structure No: 5260

Length(ft): 450

Width(ft): 28

Number of Spans: 3

Vertical Configuration: Sloping

Low Chord Elev (ft): 734

Upper Chord Elev (ft): 737

Overtopping Elev (ft): 740

Skew (degrees): 30

Guide Banks: Straight

Waterway Classification: Main

Year Built: 1934

Avg Daily Traffic:

Plans on File: Yes

Parallel Bridges No

Upstream/Downstream: N/A

Continuous Abutment: 0

Distance Between Centerlines:

Distance Between Pier Faces:

Bridge Description:

The structure is a high truss bridge with 3 - 150' spans supported by two piers, both located in the main channel of the Minnesota River. Pier #1 is on the right, looking downstream, and is supported by 82 concrete pilings driven to depths ranging from 660.28' to 637.28'. Pier #2 is supported by 82 concrete pilings driven to depths ranging from 665.96' and 654.96'. The south and north abutments are supported by creosoted piles driven to 670.53' and 665.96', respectively. The bridge has a 1% downhill grade in the

northbound direction.

Abutment Data

Left Station: 4044.67

Right Station: 3593

Left Skew (deg): 0

Right Skew (deg) 0

Left Abutment Length (ft): 77.4

Right Abutment Length (ft) 77.4

Left Abutment to Channel Bank (ft): 37

Right Abutment to Channel Bank (ft): 33

Left Abutment Protection: Riprap

Right Abutment Protection Riprap

Contracted Opening Type: IV

Embankment Skew (deg): 30

Embankment Slope (ft/ft): 0.17

Abutment Slope (ft/ft) 0

Wingwalls: Yes

Wingwall Angle (deg): 45

Pier Data

Pier ID	Bridge Station(ft)	Alignment	Highway Station	PierType	# Of Piles	Pile Spacing(ft)
1		0	3742.755	Single		
2		0	3894.92	Single		

Pier ID	Pier Width(ft)	Pier Shape	Shape Factor	Length(ft)	Protection	Foundation
1	6.5	Sharp		36.75	Riprap	Piles
2	6.5	Sharp		36.75	Riprap	Unknown

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Pier ID	Top Elevation(ft)	Bottom Elevation(ft)	Foot or Pile Cap Width(ft)	Cap Shape	Pile Tip Elevation(ft)
1	696.28	690.28	15.5	Other	637.3
2	694.76	688.76	15.5	Other	654.96

Pier Description

Pier ID 1

Pier #1 is on the right, looking downstream, and is supported by 82 concrete pilings driven to depths ranging from 660.28' to 637.28'. The foundation is dumbell shaped with 15.5' squares on each end connected by a 5' by 14' rectangle. In 1952, the pier was reinforced with stone rip-rap at a 2:1 slope from the top of the foundation due to a major scouring event that occurred in April, 1951. The remaining exposed channel bottom between the piers was lined with stone rip-rap paving to an elevation of 680'. Debris frequently accumulates in front of pier 1 and is a noted problem.

Pier ID 2

Pier #2 is on the left, looking downstream, and is supported by 82 concrete pilings driven to depths ranging from 665.96' and 654.96'. The foundation is dumbell shaped with 15.5' squares on each end connected by a 5' by 14' rectangle. In 1952, the pier was reinforced with stone rip-rap at a 2:1 slope from the top of the foundation due to a major scouring event that occurred in April, 1951. The remaining exposed channel bottom between the piers was lined with stone rip-rap paving to an elevation of 680'. Debris frequently accumulates in front of pier 2 and is a noted problem.

Pier Scour Data

Pier ID	Date	Time	USOrDS
1			

Pier ID	Scour Depth	Accuracy (ft)	Side Slope (ft/ft)	TopWidth (ft)	Apprch Vel (ft/s)	Apprch Depth(ft)	Effective Pier Width	Skew to Flow(deg)
1								0

PierID	Sediment Transport	Bed Material	BedForm	Trough (ft)	Crest (ft)	Sigma	Debris Effects
1	Live-bed	Unknown	Unknown				Unknown

PierID	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)
1				

Pier Scour Comments

Pier ID 1 **Time:** **US/DS:**

Abutment Scour

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Measurement Number	Abutment	Date	Time	US/DS	Scour Depth (ft)	Accuracy	Sediment Transport
1	Left	4/17/200	11:10	Upstream	18	2	Live-bed
2	Left	4/17/200	11:00	ownstrea	13	3	Live-bed
3	Right	4/17/200	11:00	Upstream	4	2	Live-bed
4	Right	4/17/200	11:00	ownstrea	3	2	Live-bed

Measurement Number	Velocity at Abut(ft/s)	Depth at Abut(ft)	Discharge Blocked(cfs)	Avg Velocity Blocked(ft/s)	Avg Depth Blocked(ft)
1	13.5	43	20800	2	16
2		43	20800	2	16
3	5.5	40	4200	0.67	10
4		40	4200		10

Measurement Number	Embankment Length (ft)	Bed Material	D50 (mm)	Sigma	Debris Effect
1	1775	Non-Cohesive	0.36		Insignificant
2	1775	Non-Cohesive	0.36		Insignificant
3	630	Non-Cohesive	0.36		Insignificant
4	630	Non-Cohesive	0.36		Insignificant

Abutment Scour Comments

MeasurementNo 1

The left upstream abutment was exposed to very high velocities coming out of the floodplain. Intense boils and eddys were also present through the bridge opening at the left abutment. The left abutment slope and adjacent pier (#2) both had scour protection (rip-rap), which most likely amplified the amount of scour in the channel at the left abutment.

MeasurementNo 2

The left upstream abutment was exposed to very high velocities coming out of the floodplain. Intense boils and eddys were also present through the bridge opening at the left abutment. The left abutment slope and adjacent pier (#2) both had scour protection (rip-rap), which most likely amplified the amount of scour in the channel at the left abutment.

MeasurementNo 3

MeasurementNo 4

ContractionScour

Measurement Number	Contracted Date	Contracted Time	Uncontracted Date	Uncontracted Time	US/DS	Scour Depth(ft)
1	4/17/2001	11:00	4/17/2001	11:55		15

Measurement Number	Accuracy	Contracted Avg Vel(ft/s)	Contracted Discharge(cfs)	Contracted Depth(ft)	Contracted Width(ft)
1	2	4	69800	49	390

Measurement Number	Uncontracted Avg Vel(ft/s)	Uncontracted Discharge(cfs)	Uncontracted Depth(ft)	Uncontracted Width(ft)	Channel Contraction Ratio
1	2.8	32000	34	360	0.54

Measurement Number	Pier Contraction Ratio	Scour Location	Eccent-ricity	Sediment Transport	Bed Form	Debris Effects
1		Main Channel	0.2	Live-bed	Unknown	Unknown

Measurement Number	D95 (mm)	D84 (mm)	D50 (mm)	D16 (mm)	Sigma Bed Material	Bed Material
1						Non-Cohesive

Contraction Scour Comments

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Measurement No. 1

A few logs were jamed perpendicular to the flow along the nose of pier #1. The deepest area of scour through the bridge reach was observed to be downstream of the bridge on the left side of the channel (between the left abutment and pier #2). The riprap protection on the abutments and piers greatly diminished scour through the bridge and focused the contracted flow energy beyond the bridge and the protected areas, resulting in the deep scour hole downstream of the bridge (see measurement 2).
Detailed data of the bridge reach was collected during the flood with a manned boat and ADCP. Inspection of the "approach" section (one bridge width upstream) revealed a large discharge relative to that of the contracted opening and a bed elevation similar to the contracted section. It was discovered that the upstream bend forced a majority of the left floodplain flow back into the main channel before the "approach" section. A cross section made further upstream showed much less discharge, which was consistent with channel discharge downstream of the bridge opening, and an average channel elevation ~ 15 higher than contracted section.The widths and corresponding hydraulic characteristics for the uncontracted sections are representative of the portion of the channel in which live-bed transport would be expected.

Stage and Discharge Data

Peak Discharge					Flow		Peak Stage					Stage	Water	Return
year	mo	dy	hr	mi	(cfs)	Qacc	year	mo	dy	hr	mi	(ft)	Temp (C)	Period(yr)
					73,200							728.5		34

Hydrograph

Supporting Files

MN25.lpk - contour plot of detalied bathymetry data collected during April, 2001 flood, displayed in AmTec's Tecplot software package.

Site Photos:

DSCN0068.jpg - DSCN0107.jpg - Photos taken during April, 2001 flood, description of each photo is documented in MN25_Photos.doc Word file.

HWY250041.jpg - HWY250068.jpg - Photos taken during October, 2001 low-flow survey, description for each is documented in MN25_Post-Flood_Photos.doc Microsoft Word file.

Minn25.jpg - USGS topo quad of the bridge site.
BellePlaine(Aerial).jpg - Aerial photo of MN 25 bridge site
BellePlaine(Aerial)2.jpg - Aerial photo of MN 25 bridge site
BellePlaine(Aerial)3.jpg - Aerial photo of MN 25 bridge site
BellePlaine(Aerial)4.jpg - Aerial photo of MN 25 bridge site

Surveyed Sections:

DS_xsection(HEC-RAS).xls - Excel spreadsheet containing surveyed data for the exit section used in a HEC-RAS model of the reach.
US_xsection(HEC-RAS).xls - Excel spreadsheet containing surveyed data for the approach section used in a HEC-RAS model of the reach.
100'_US.xls - Excel spreadsheet containing surveyed data for the section 100' upstream of bridge; location of overbank scour hole.
DS_Face.xls - Excel spreadsheet containing surveyed data for the downstream bridge face.
US_Face.xls - Excel spreadsheet containing surveyed data for the upstream bridge face.
Hwy25_HEC-Ras.xls - Excel spreadsheet summarizing the elev. and stationing for all sections in the HEC-RAS model of the reach.
MN25_GrainSizeDist.xls - Bed material grain size distribution for the site, determined by analysis of samples collected during post-flood survey.

ADCP_Data.zip - WinZip file containing all ADCP data collected in the reach during April, 2001 flood. The ADCP 3-D velocity data for each transect has been processed into depth-integrated 2-D velocity data and summarized in the .vel files.